The revamping of the state's educational system led to the abandonment of the one-room schoolhouse. Centralized state agencies administering welfare and relief programs came into existence ending the almshouse system.

Mass-produced goods and household amenities introduced earlier became available to nearly all segments of the population by the end of the period. Lower socio-economic white and black communities, migrant worker dwellings, Mennonite farmsteads, and other ethnic enclaves are not expected to exhibit patterns seen in the larger community. For this reason, sites associated with these groups can provide information on the perpetuation of traditional behavior, technology, and social organization in modern society. The acceptance of selected modern elements by these communities could also be obtained by investigating these sites. One migrant worker dwelling (K-2065) has been identified in the project area.

PREDICTIVE MODELS

The previous section of this report presented the inventories of known, and previously recorded, prehistoric and historic archaeological sites. As was noted earlier, the sites recorded in the state records do not represent all the cultural resources in the study area, or even an unbiased sample. Consequently, it is necessary to use projections of potential archaeological site locations (predictive models) to make management and planning decisions about cultural resources. This section describes the uses of predictive models in prehistoric and historic archaeology and applies various predictive models to the study area.

Predictive Models and Prehistoric Archaeological Sites

Predictive models must be applied to the study of prehistoric archaeological resources for a number of reasons. First, a complete inventory of all prehistoric archaeological sites is not possible due to cost limitations. Also, archaeological site discovery often entails at least partial site destruction. Thus, it is necessary to develop predictions of where various types of prehistoric archaeological sites of various ages are likely to be found.

Development of these predictions for prehistoric sites can be accomplished in a number of different ways. One method utilizes detailed analyses of modern resource distributions and studies of living hunter-gatherer populations to predict what sorts of places similar populations might have inhabited in the past (eg., Jochim 1976). Because of the detailed nature of the required resource distribution analyses and the limitations of the currently available paleoenvironmental data base, modern environments must be used to develop the models. While these models have been applied to, and work well for, late prehistoric groups (eg., Thomas et al. 1975), the projections of these models and their predictions into the more distant past, is risky, at best, as noted by Binford (1978). Also, the predictions generated from the application of these models in the Middle Altantic Coastal Plain (Cameron 1976) have been contradicted by empirical data from archaeological sites (Custer, Stiner and Watson 1983; McNamara 1982). Another method of generating predictive models uses samples of modern site distributions to develop quantitative assessments of densities of site per unit areas of various size and configuration (Wilke and Thompson 1977; Luckenbach and Clark 1982). These studies do not distinguish among the various classes of archaeological sites encountered and, therefore, such studies are not appropriate for all kinds of resource management because they ignore the cultural content of archaeological sites as well as the potential to yield useful data which establishes these sites' significance (Raab and Klinger 1977). Also, these studies do not link the site densities with locational data which allow the plotting of areas of differential site densities.

The alternative to the approaches noted above is the traditional approach to predictive modelling developed and utilized by William M. Gardner and his students at Catholic University. Gardner's (1978, 1982) studies consider the existing data on site locations for various classes of sites from different time periods. Correlations between site locations and environmental settings are then determined. If controlled samples are available, statistical analyses may be used (Custer 1980; Wells et al. 1981; Custer and Galasso 1983; Eveleigh et al. 1983); however, if uncontrolled samples are utilized the analyses are more impressionistic (Gardner 1978, 1982; Custer and Wallace 1982). Whatever the type of analysis, a series of descriptions of typical site locations are developed. These descriptions may be in the form of listings of significant variables (Gardner 1978, Cunningham 1983), narrative descriptions of typical site locations (Stewart 1981; Wall 1981; Tolley 1983), diagrams of site locations (Hoffman and Foss 1980; Custer and Wallace 1982; Custer 1983a, 1983b, 1983c), descriptions of site locations using quantitative data (Hughes and Weissman 1982), or quantitative projections of numbers and types of sites within varied environmental zones (Custer 1980; Custer and Galasso 1983). No matter what their form, these predictions can then be used for resource management and further research and testing. This approach will be used in this study and is preferable to the other approached for management purposes because it considers the cultural content of sites and specifically predicts their locations.

The approach to predictive model generation noted above can be applied to the study area at a variety of levels. The most general level is to use the initial predictive models developed for the Delaware plan for the management of prehistoric cultural resources (Custer 1983b) and a similar plan developed for the Upper Delmarva region of Maryland (Custer 1983c). In these management plans, a series of diagrams showing relationships among sites and typical site locations were formulated. Also, tabular summary descriptions of typical site locations were prepared. These tabular summaries and diagrams were then combined to define study units for each of the major cultural periods. In order to apply these models to the present study, the proposed highway corridor was plotted in relation to the study areas from the state plan and the relevant diagrams and descriptions of typical locations noted. The relevant site models and study units are described below for each cultural period.

For the Paleo-Indian period, the entire project area falls within a study area that has a low data quality and a low probability for all types of Paleo-Indian sites (Custer 1983b). Figure 5 shows the typical environmental locations for Paleo-Indian sites that can be expected to occur in the study area. These sites include base camps (habitation sites) and hunting and maintenance sites where various resources were procured. Generally, this model would be most applicable in the bay/basin area noted in Figure 4, although similar patterns would be seen with a lower frequency throughout the project area. Figure 6 shows a "serial" model of group movements (Custer, Cavallo, and Stewart 1983) that would most likely have linked sets of the site locations noted in Figure 5. The serial model assumes that Paleo-Indian groups would move from base camp to base camp with movements dictated by resource availability. As groups moved, various hunting locales and lithic resources would be used on a serial basis. Application of the serial model is based on the fact that lithic resources within the project area are small, scattered, and numerous (Custer and Galasso 1980). Table 8 provides summary descriptions of typical Paleo-Indian site locations for the project area.

KEY TO SITE LOCATION MODELS

(B) – MACRO-BAND BASE CAMP

(b) – MICRO-BAND BASE CAMP

[p] – PROCUREMENT SITE

(H) – HUNTING SITE

[m] – BASE CAMP MAINTENANCE STATION

(Q) – QUARRY SITE

c – CACHE – ISOLATED FIND

M – MINOR MORTUARY/EXCHANGE CENTER

M – MAJOR MORTUARY/EXCHANGE CENTER

QB – QUARRY RELATED BASE CAMP

QR – QUARRY REDUCTION SITE

FIGURE 5

PALEO-INDIAN SITE LOCATION MODEL

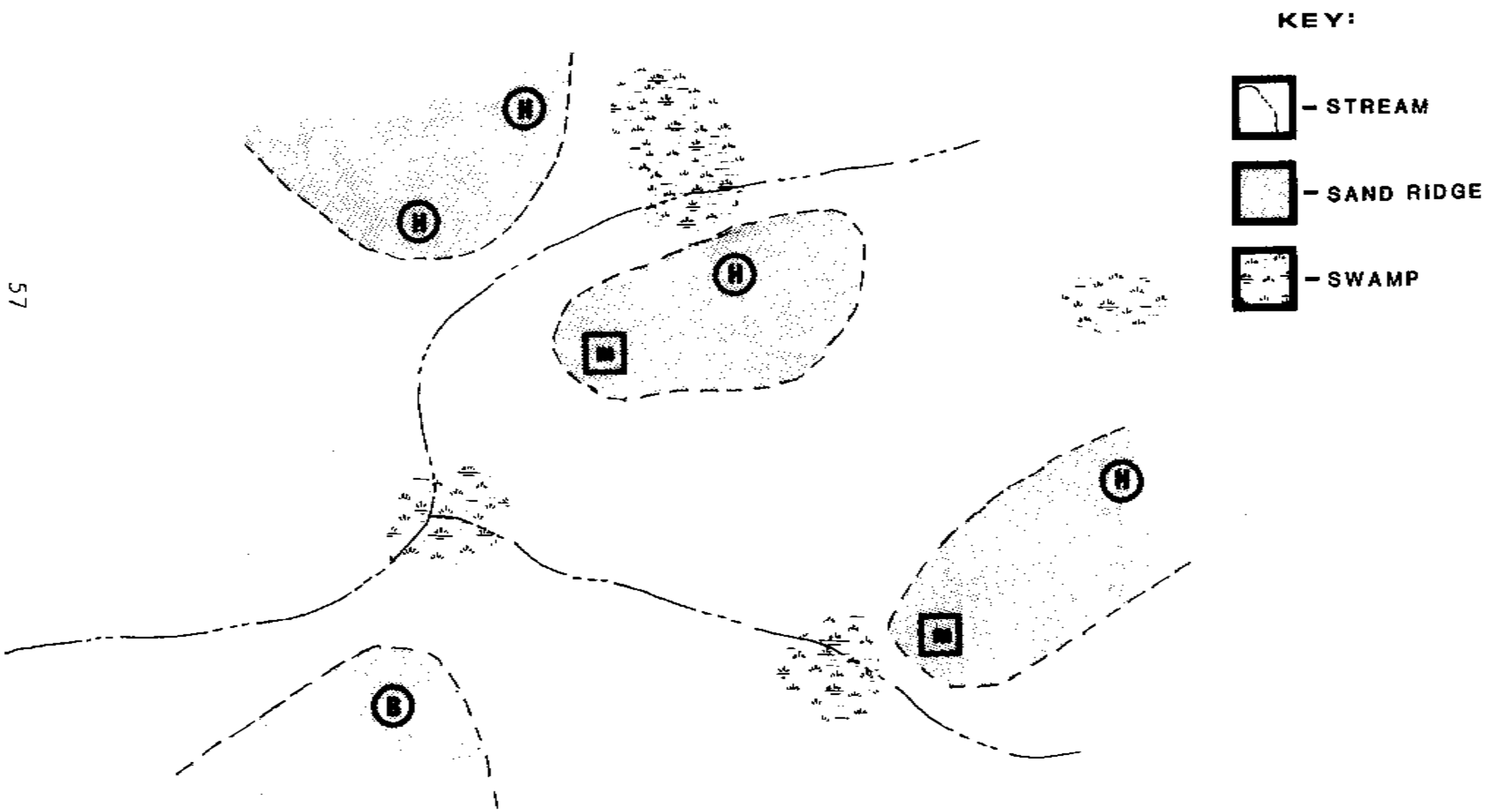
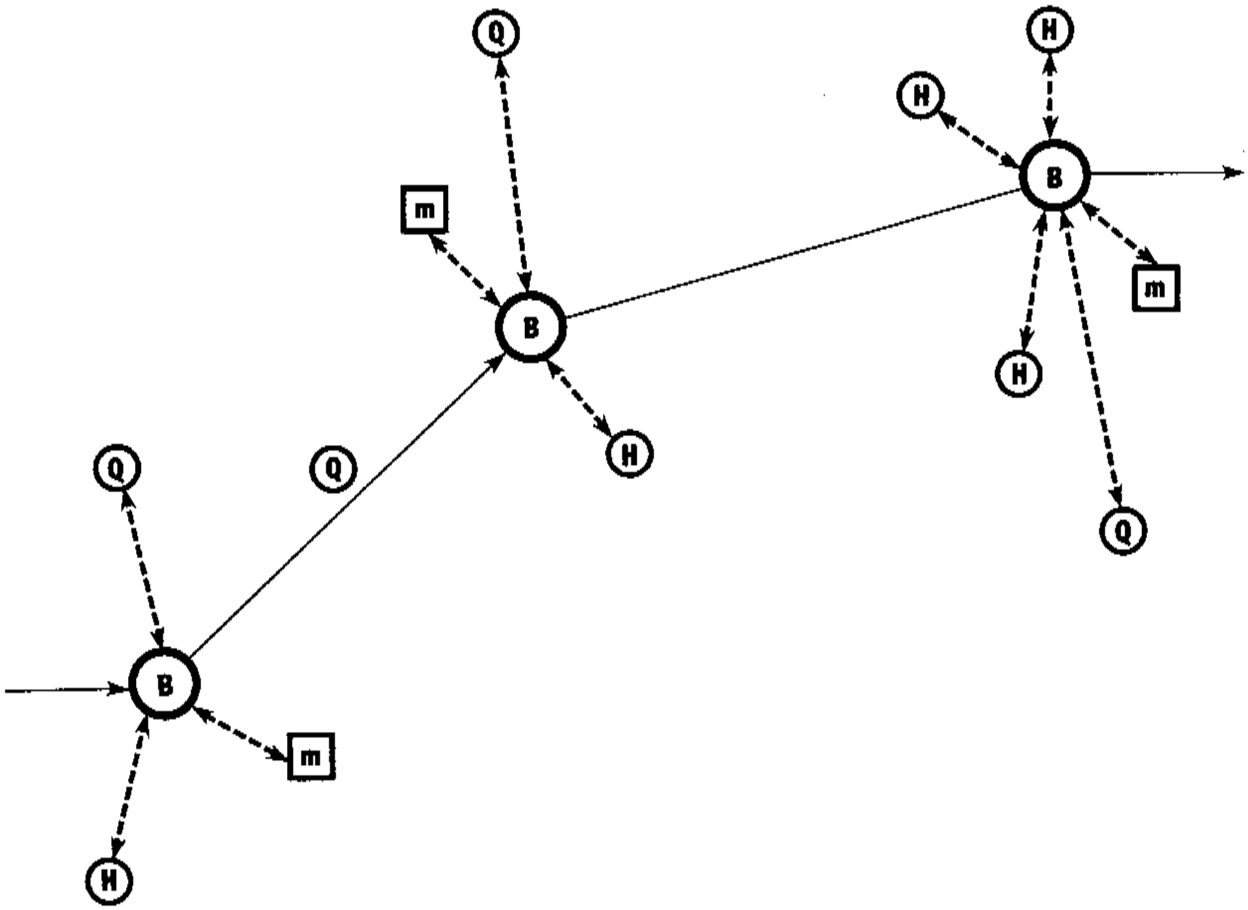


FIGURE 6

SERIAL SETTLEMENT/LITHIC UTILIZATION MODEL



KEY:

- PERIODIC FORAY

- GROUP MOVEMENT

Table 8

Paleo-Indian Site Locations

Site Types	Locations
Base camp	well-drained ridge in areas of maximum habitat overlap
Base camp maintenance station	game attractive locale close to base camp (swamps, bay/basin)
Hunting site	game attractive locales away from base camp (swamps, bay/basin)

For the Archaic Period, the project area includes two study units (Custer 1983b). The study units are the Delaware River/Bay major drainage zone, which has relatively poor site distribution data, and an area with unknown Archaic site potential. Table 9 notes the study units, data quality, and typical site locations. The location of these study units in relation to the project area is shown in Figure 7. The general model of group movements and relationships among Archaic sites is shown in Figure 8. In this model, large social units (macro-bands) inhabit especially rich resource zones during seasons of highest environmental productivity. While living at these macro-band base camps, small work groups would make periodic forays to good hunting and gathering locales to procure resources. As local resources became depleted, either from seasonal factors or human exploitation, social groups would break into smaller units (micro-bands) and disperse to smaller base camps in other, less productive, environmental zones (Custer 1982a:Chapt. 3).

Table 9

Archaic Site Locations and Study Units

Study Units	Data Quality	Site Types	Locations
Major Drainage	poor	macro-band base camp	low terraces along major drainage, especially at vicinity or lower order confluences
		micro-band base camp	upper terraces of major drainage along lower order tributaries and at low order stream confluence up to 10 km from major drainage
		procurement site	swamp floodplains of major and minor drainages, alluvial fans associated with swamps, bogs, and lithic sources
All remaining areas of Delaware	poor	?	?

FIGURE 7

ARCHAIC STUDY UNITS AND PROJECT AREA

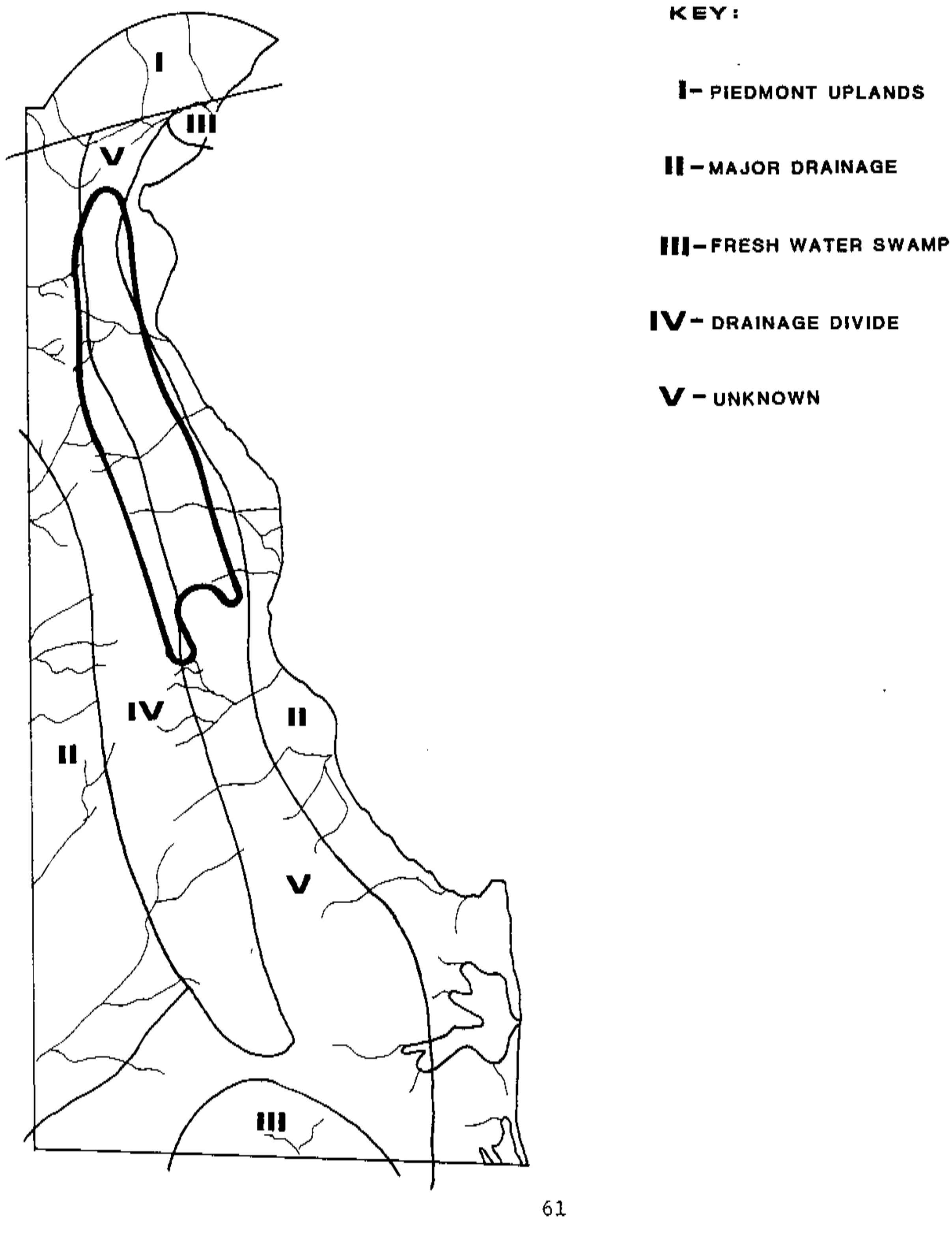


FIGURE 8

GENERAL ARCHAIC SITE MODEL

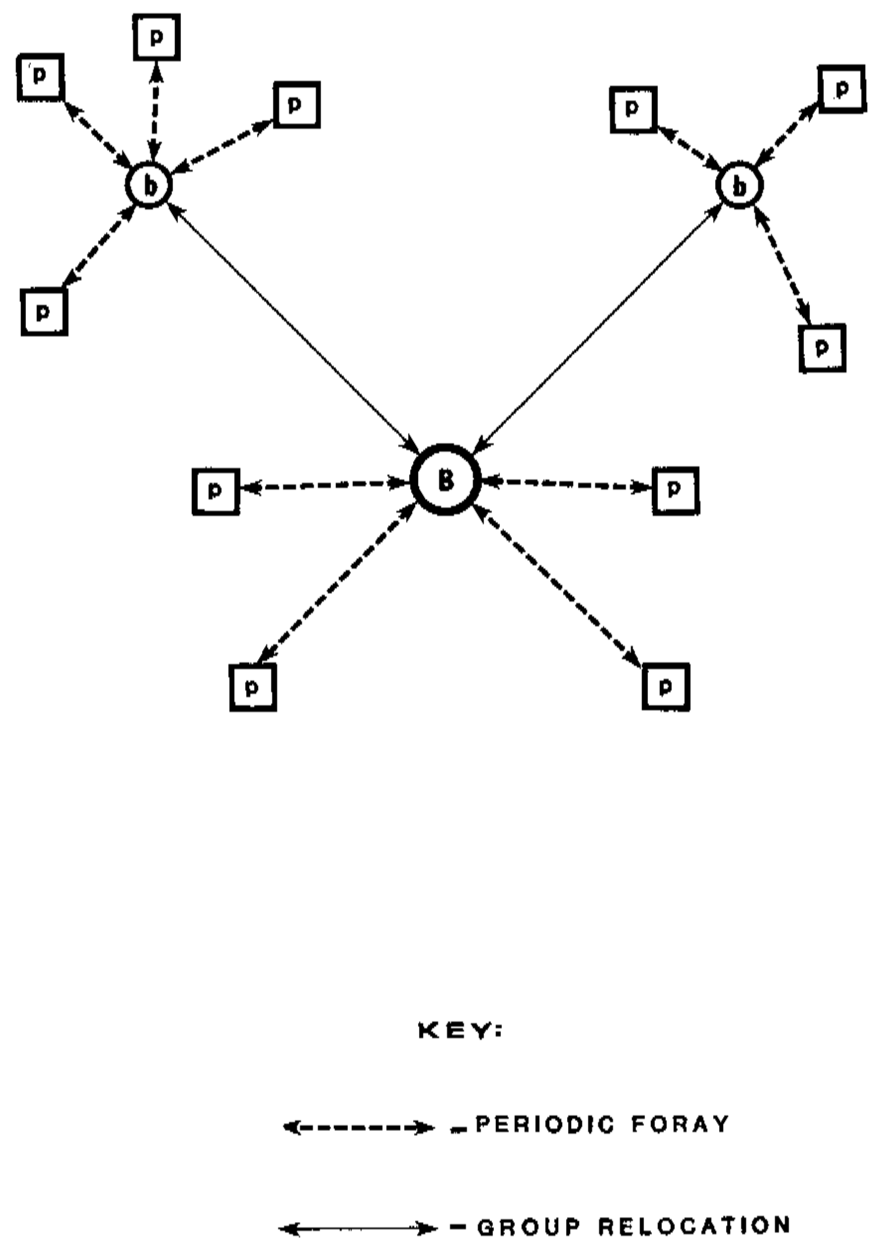


FIGURE 9

DELAWARE SHORE MODEL OF ARCHAIC SITE LOCATIONS

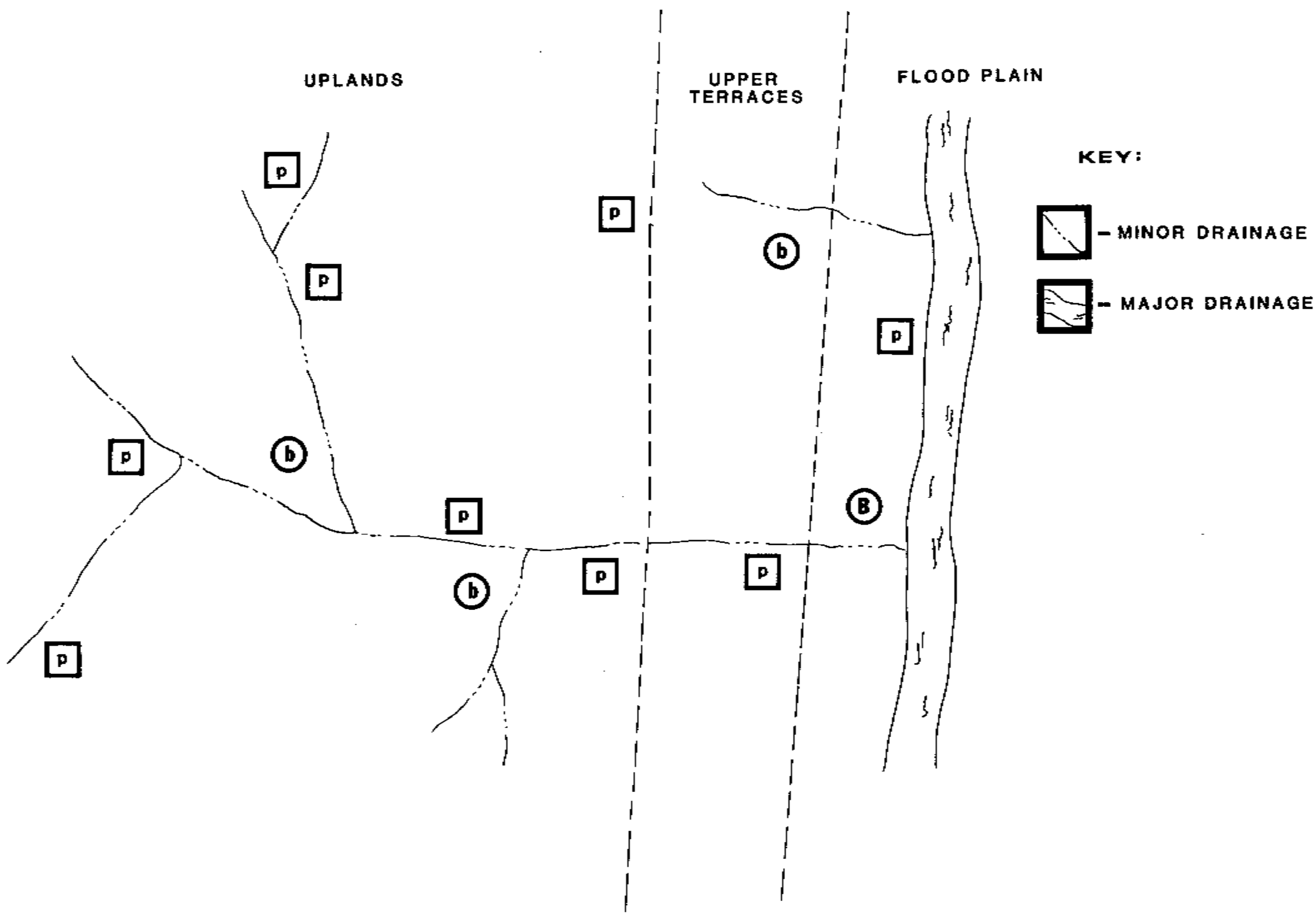


FIGURE 10

SWAMP/MARSH ZONE MODEL OF ARCHAIC SITE LOCATIONS

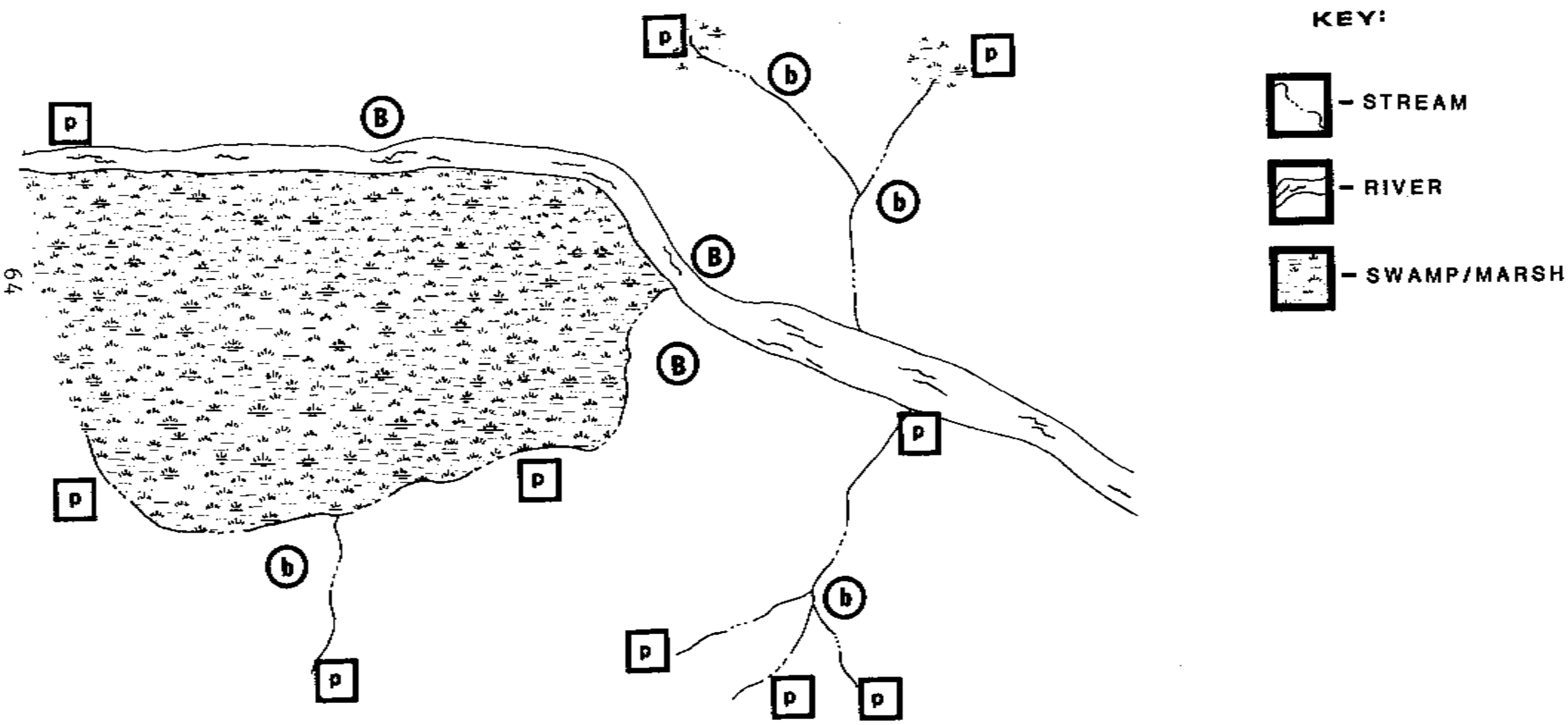
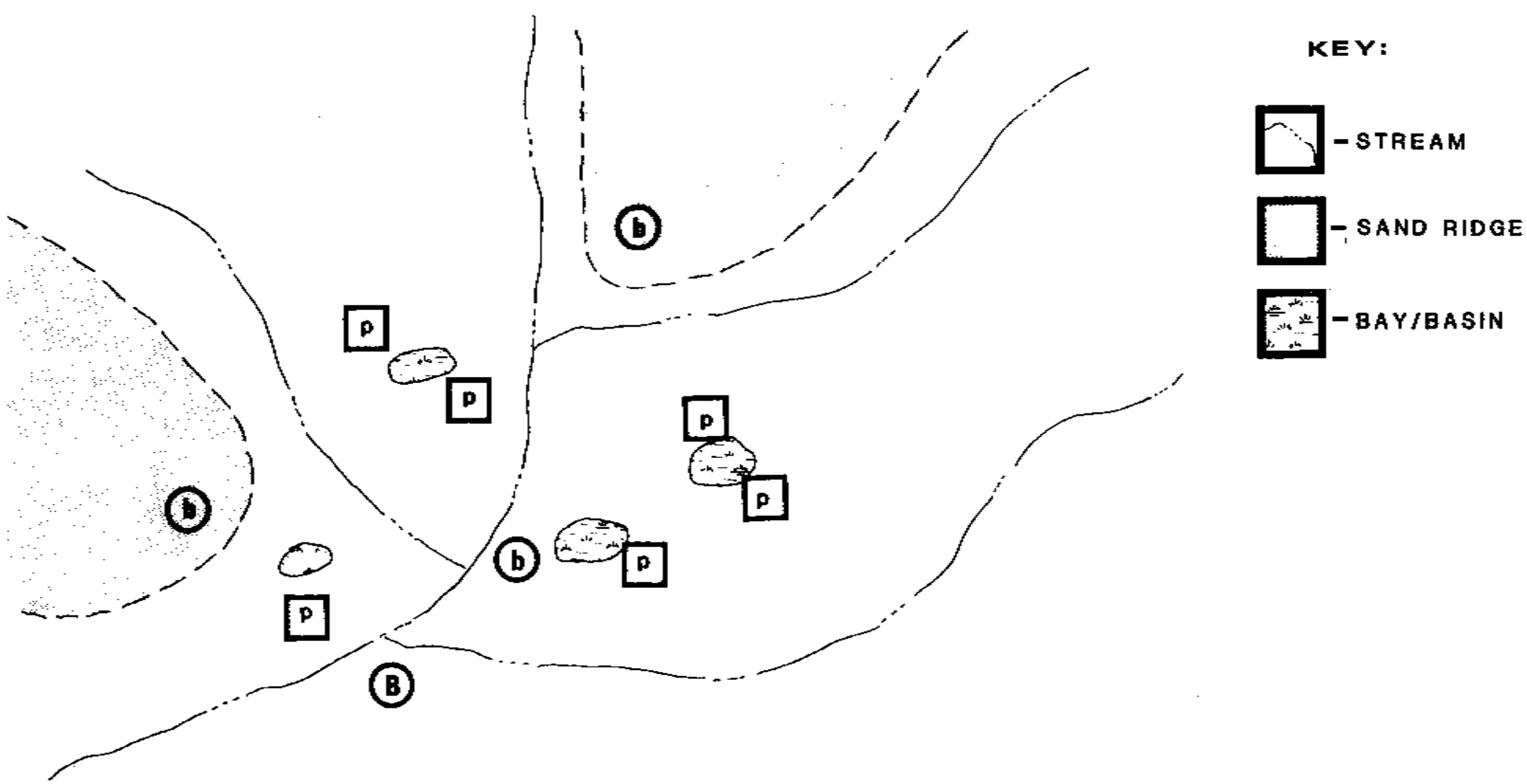


FIGURE 11

BAY/BASIN ZONE MODEL OF ARCHAIC SITE LOCATIONS

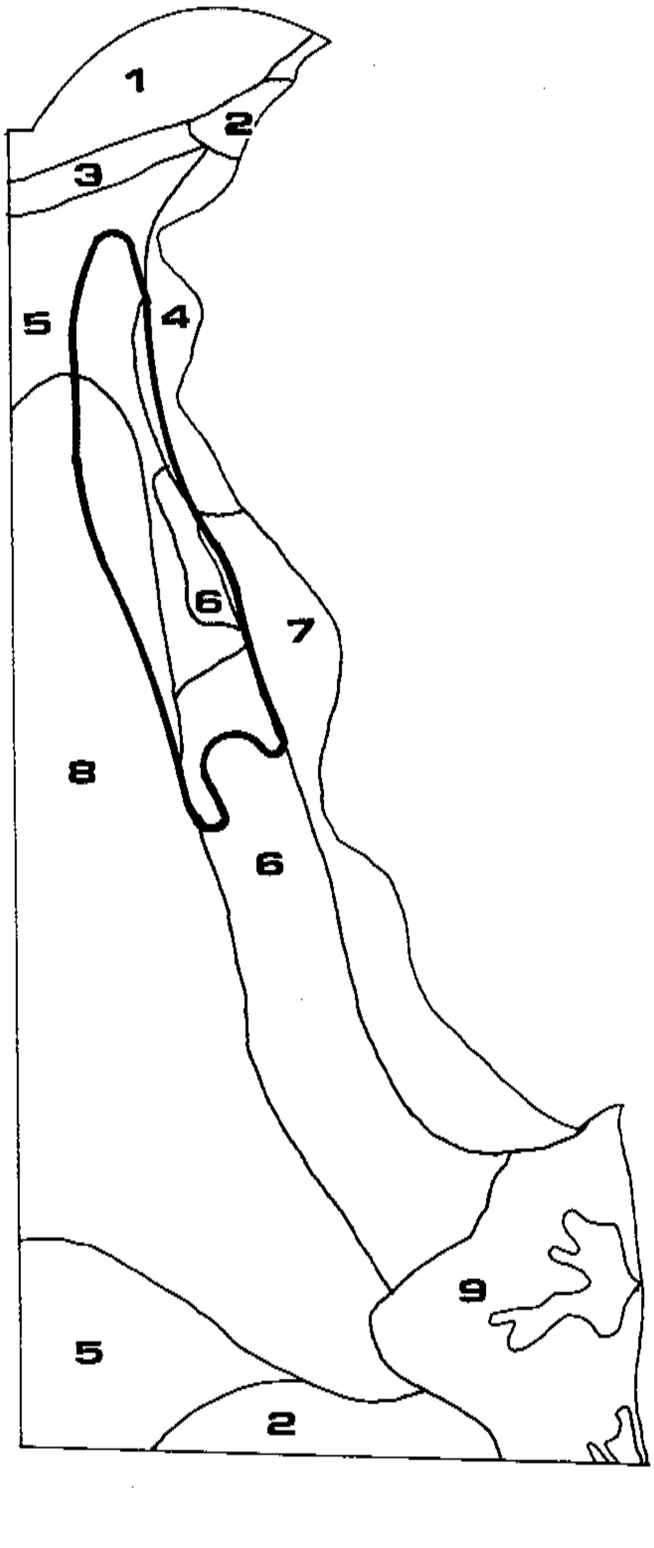


The Woodland I Period has a variety of study units and site locations that apply to the project area. The greater variety compared to earlier periods is due to increasing social complexity of the prehistoric groups and also to more complete, and specific, archaeological data. Figure 12 shows the study units in relation to the project area. Four separate study units are present. Table 10 lists the study units and their data quality, and describes typical site locations within each study unit. Figure 13 shows the general model of Woodland I site types and the possible groups movements among the site types. In general, the Woodland I model includes the same component site types as the Archaic model and has the same pattern of group movements. However, in the Woodland I model, the macro-band base camps are larger and inhabited for longer periods of time by larger social units and more people. Also, Woodland I base camp sites are likely to contain remains of house structures, storage/refuse pits, and middens (Custer 1982) not seen at Archaic macro-band camps. Typical locations of these site types for different environmental zones within the project area are noted in Figures 14-16.

An important class of Woodland I sites not noted in the models presented above includes the mortuary-exchange centers described in the regional prehistory for Barkers Landing, Delmarva Adena, and Webb complex times (Custer 1982:32-33). To a certain extent, Barkers Landing exchange centers are addressed in the models presented above because the exchange centers are located at the largest macro-band base camps (Custer 1983a: Chapt. 4). However, by Delmarva Adena Complex times, the mortuary/exchange sites are no longer directly associated with living sites (Custer 1982:34-36). Figure 17 shows the proposed model of Delmarva Adena Complex groups and the inferred social links among sites. During Webb Complex times a similar pattern is present and even more pronounced (Custer and Galasso 1983). Figure 18 shows the settlement pattern for Webb Complex societies.

FIGURE 12

WOODLAND I
STUDY UNITS AND PROJECT AREA



KEY:

1 - PIEDMONT UPLANDS

2 - INTERIOR SWAMPS

3 - FALL LINE

4 - DELAWARE RIVER SHORE

5 - INTERIOR

6 - MID-DRAINAGE ZONE

7 - BAY SHORE

8 - INTERIOR DRAINAGE DIVIDE

9 - EMBAYED DRAINAGES

Table 10

Woodland I Study Units and Site Locations

Study Units	Data Quality	Site Types	Locations
Delaware River Shore	poor	macro-band base camp	low terraces, especially at low order confluences
		micro-band base camp	upper terraces along low order tributaries and at low order stream confluences up to 10 km from major drainage
		procurement sites	swampy floodplains of major and minor drainages, alluvial fans associated with swamps, bogs, and lithic sources
Interior Zone	poor	micro-band base camp	well-drained knolls at springs and stream confluences
		procurement sites	well-drained knolls at swamp and springs
Mid-Drainage Zone	fair	macro-band base camp	low terraces of major drainages at stream confluences and at saltwater/ fresh water interface of the marsh.
		micro-band base camp	confluences of low order streams and tidal marshes
		procurement sites	along minor and ephemeral drainages adjacent to poorly drained woodlands and on small sand ridges and knolls
		major mortuary exchange center	along major drainages at central location to several macro-band base camps
		minor mortuary	associated with micro-band base exchange centercamps or along major drainage at central location to several micro-band base camps.
Bay Shore Zone	poor	micro-band base camp	upper terraces near freshwater sources and tidal marshes
		procurement sites	along tidal marshes and swampy low order floodplains
		mortuary sites	centralized locations to several micro-band base camps

FIGURE 13

GENERAL WOODLAND I SITE MODEL

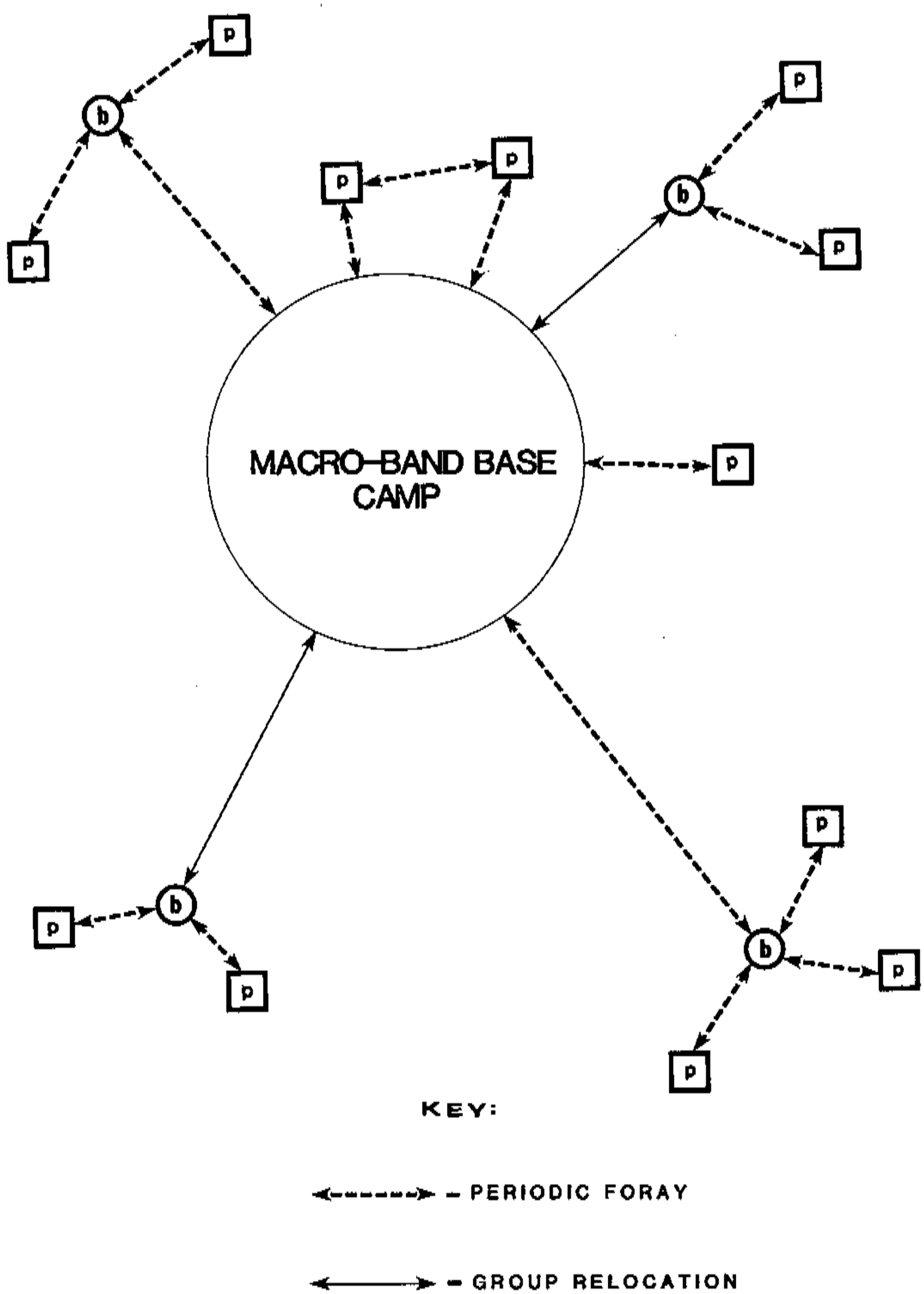


FIGURE 14

SWAMP/MARSH ZONE MODEL OF WOODLAND I SITE LOCATIONS

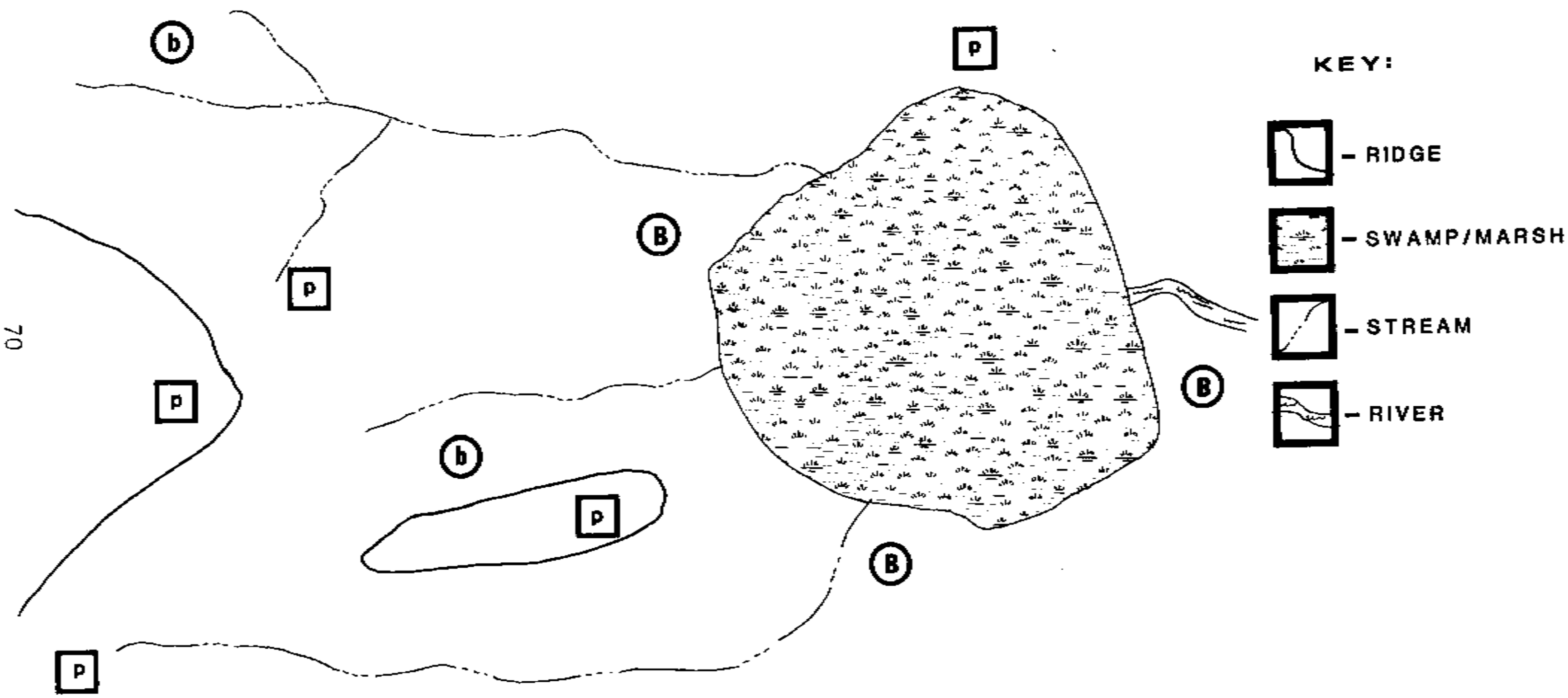


FIGURE 15

MAJOR DRAINAGE/MID-DRAINAGE ZONE MODEL OF WOODLAND I SITE LOCATIONS

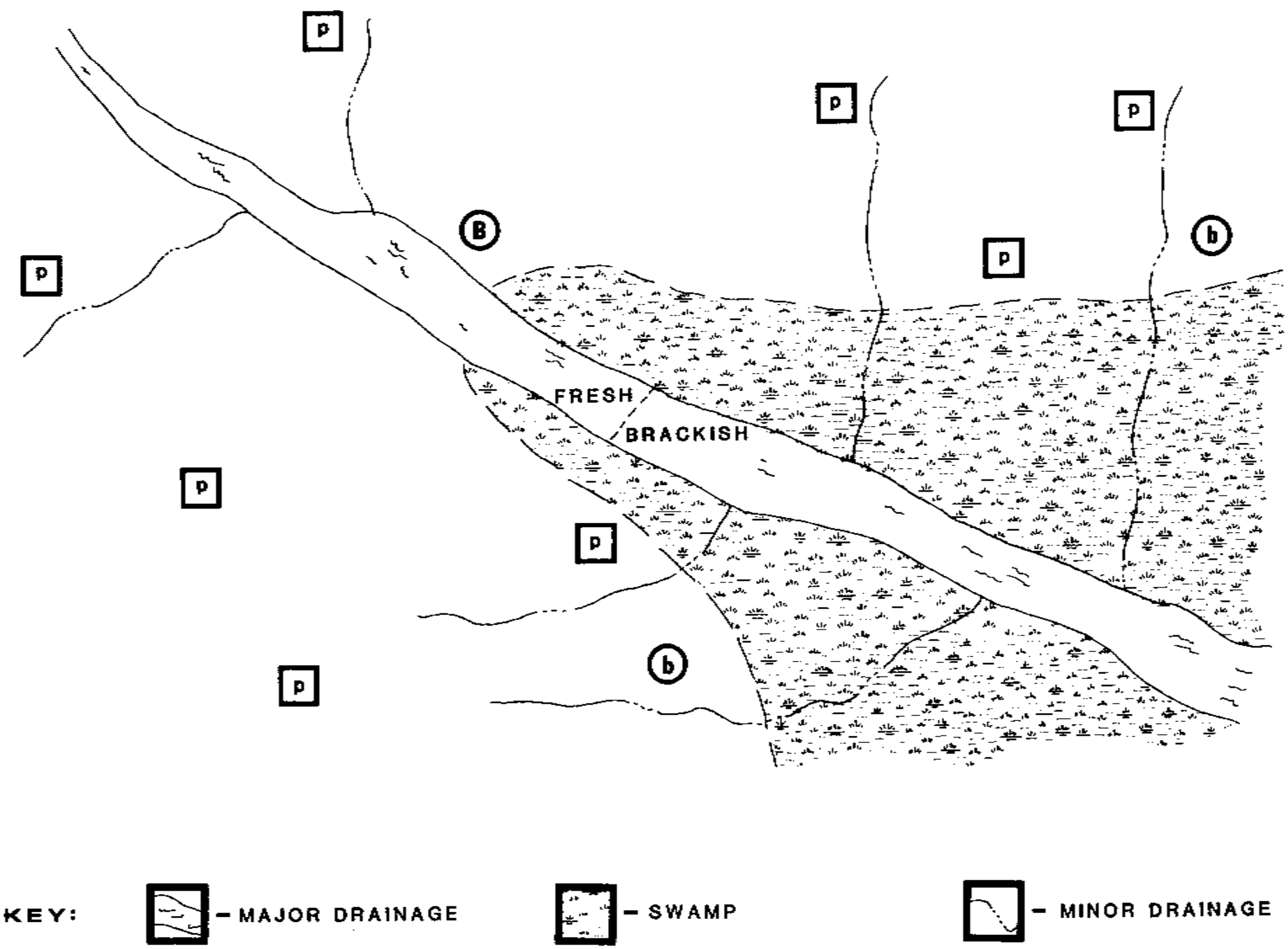


FIGURE 16

COASTAL ZONE MODEL OF WOODLAND I SITE MODELS

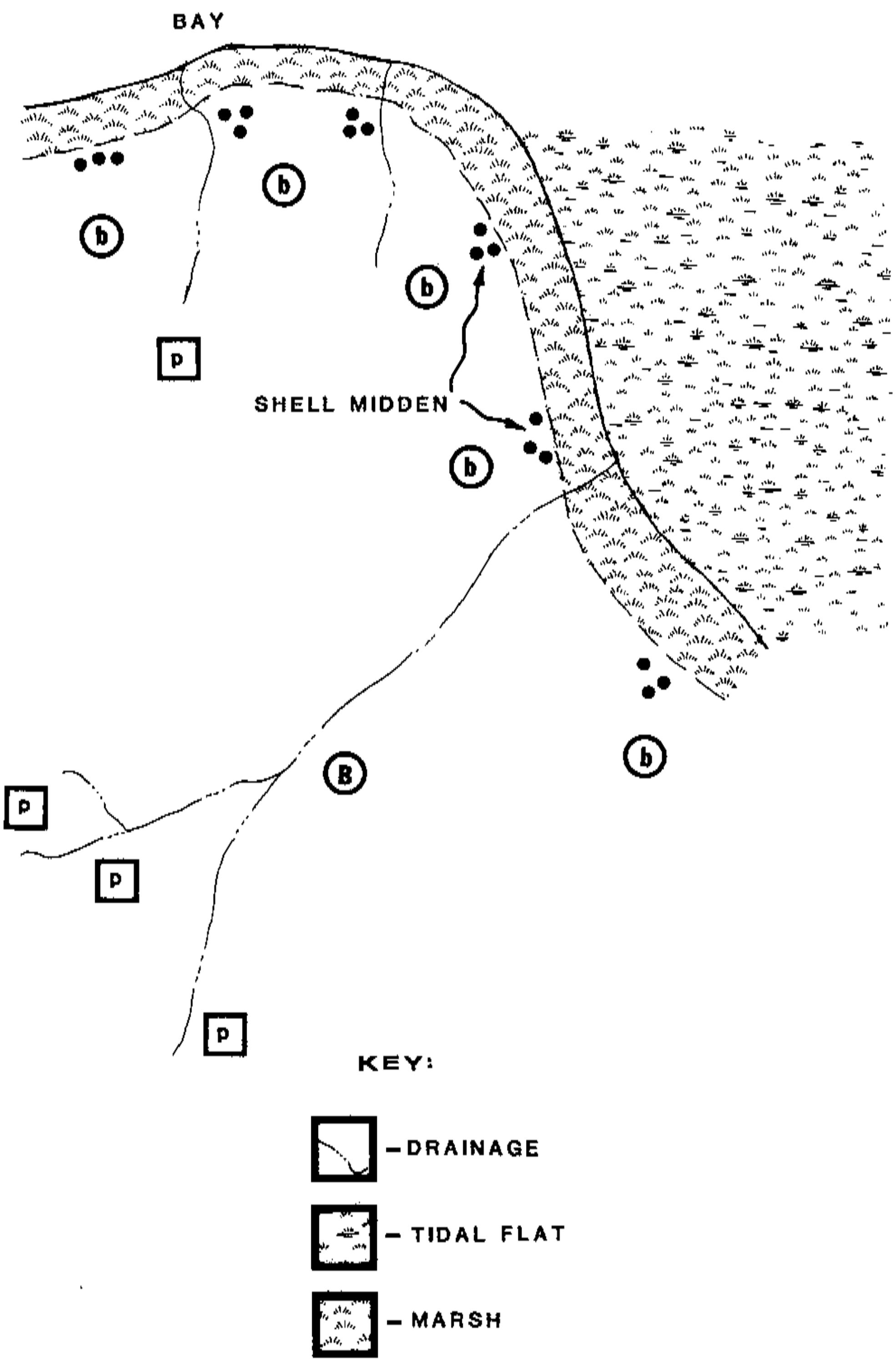


FIGURE 17

DELMARVA ADENA COMPLEX SETTLEMENT MODEL

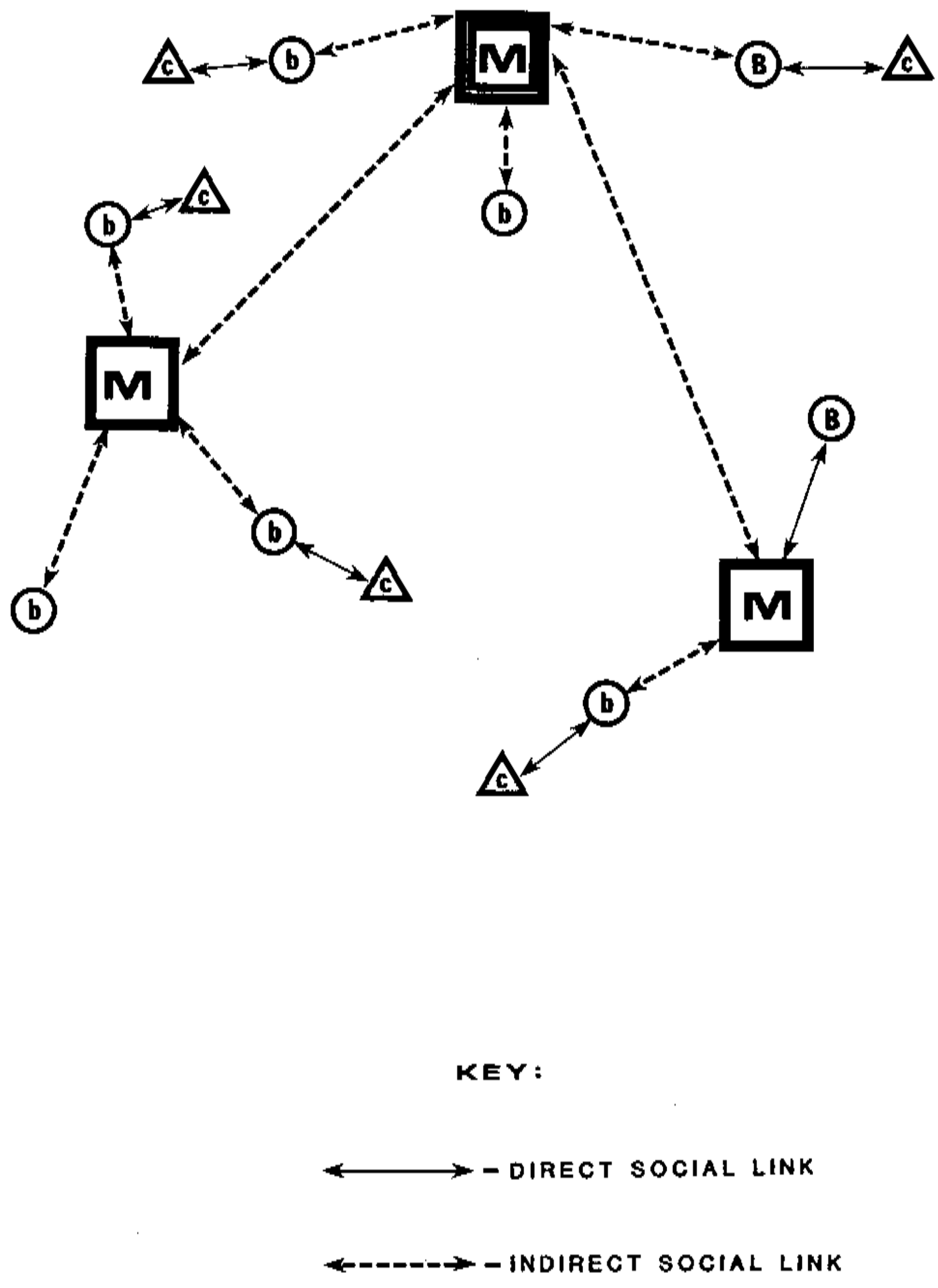
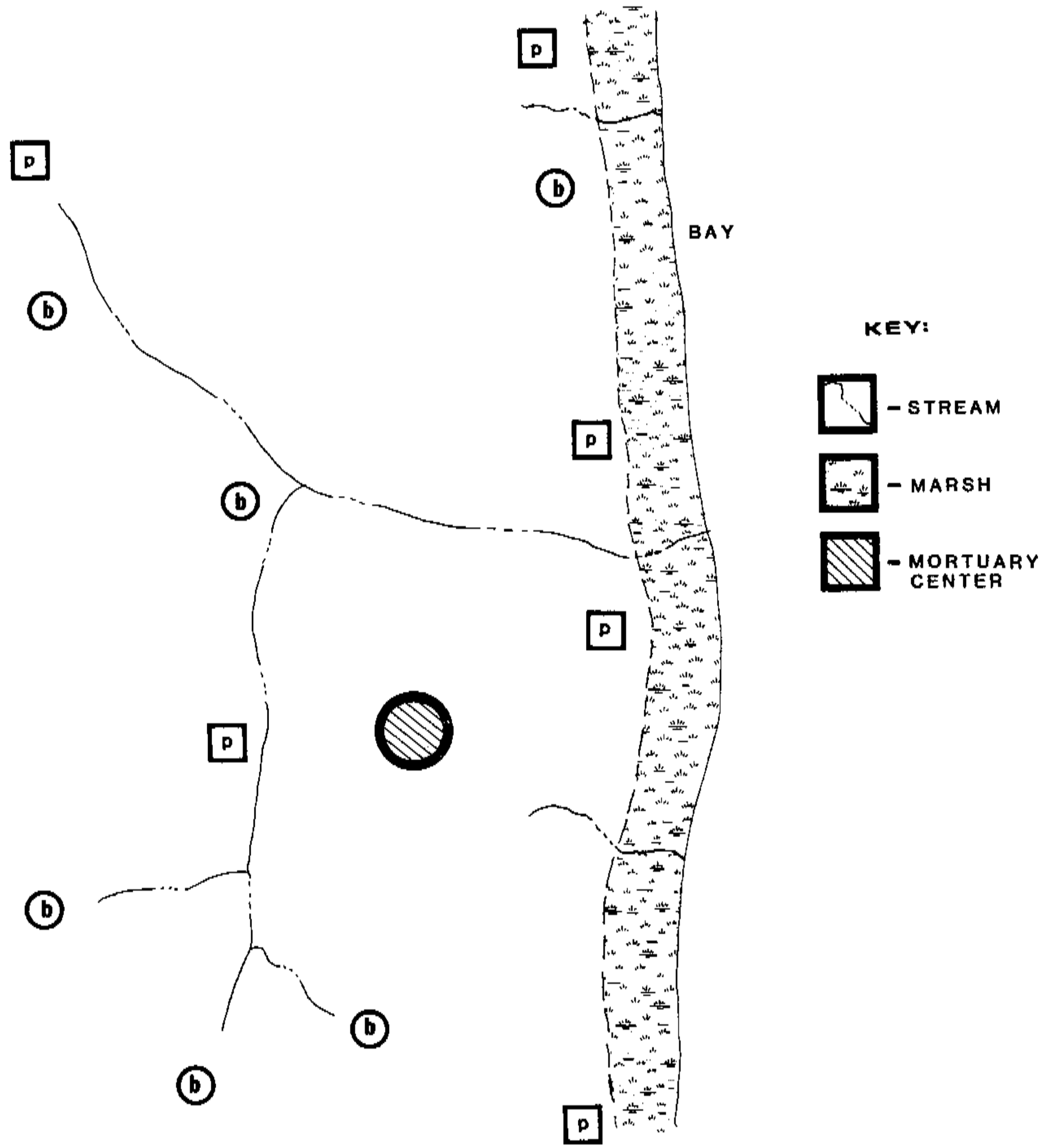


FIGURE 18

WEBB COMPLEX SETTLEMENT MODEL



The project area falls into four Woodland II study units as shown in Figure 19. Table 11 lists the study units and data quality and summarizes the site locations in each study unit. The site types recognized for the Woodland II Period are the same as those noted for the Woodland I and Archaic periods. For the Woodland II Period, the models developed by Thomas et al. (1975) can be used to describe typical site locations. Thomas et al. analyzed the food resource potential of various environmental zones on a seasonal basis and then generated a series of hypothetical site models. Each model assumed a variable degree of residential stability and each was compared to known site distributions to see which ones were the most accurate. The three most sedentary models all seemed to apply to Delaware Woodland II societies and Custer (1983a;n.d.) notes that varied models apply in different areas. Figure 20 shows the Woodland II model that applies to Slaughter Creek Complex sites on the major drainages of the southern portion of the project area and Figure 21 shows the Woodland II model that applies to Minguannan Complex sites.

Table 11

Woodland II Site Locations and Study Units

Study Unit	Data Quality	Site Types	Locations
Delaware Shore Zone	poor	macro-band base camp	low terraces, especially at low order confluences
		micro-band base camp	upper terraces along low order tributaries and at low order stream confluences up to 10 km from major drainage
		procurement sites	swampy floodplains of major and minor drainages
Interior Zone	poor	micro-band base camp	well-drained knolls at springs and stream confluences
		procurement sites	well-drained knolls at swamp and springs
Mid-Drainage Zone	fair	macro-band	low terraces of major drainages at

Table 11

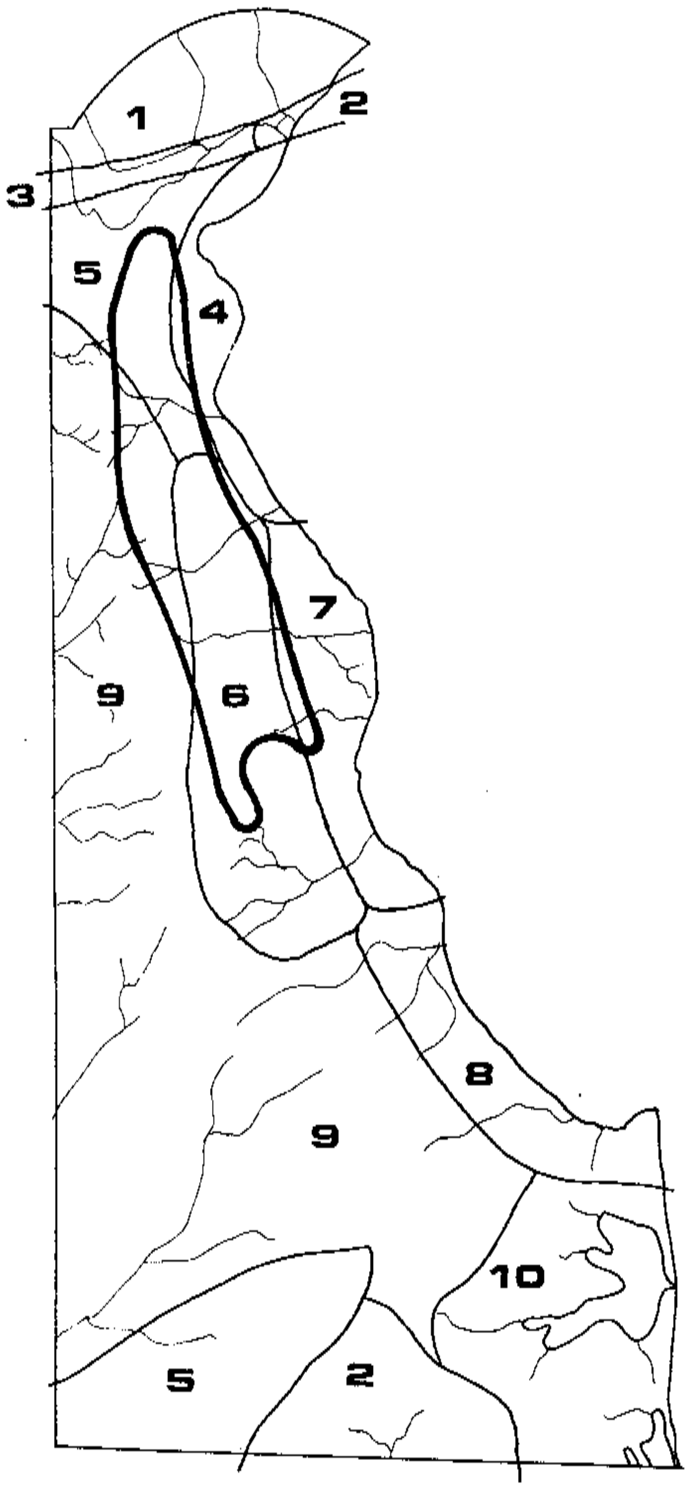
		base camp	stream confluences and at saltwater/ freshwater interface of the marsh.
		micro-band base camp	confluences of low order streams and tidal marshes
		procurement sites	minor and ephemeral drainages adjacent to poorly drained woodlands and on small sand ridges and knolls
Bay Shore Zone	fair	macro-band base camp	well-drained knolls with access to freshwater (springs and streams)
		micro-band base camp	confluences of minor drainages with marsh settings
		procurement sites	along tidal marshes and swampy low order floodplains

For the Contact Period, the project area falls within the zone that can be linked with the Lenape ethnic group (Goddard 1978: Map 2). There are few data on Contact archaeological sites throughout Delaware (Custer 1983a:Chapt. 6) and no site location models can be presented. However, it can be noted that Woodland II models are probably applicable up to the point in time when diseases introduced by Europeans caused depopulation, and other effects of Contact, including warfare and migration, caused population disruptions.

The models noted above provide a general guide to the types of locations where various types of prehistoric archaeological sites are likely to occur. However, the form in which they are presented above is not sufficient by itself for assessing the archaeological potential of a specific area, such as various portions of the project area. It is necessary to carry out additional analysis of the terrain of a given area and then compare the results of the analysis with the environmental settings depicted, or described in the models. Based on observed similarities, or differences, the archaeological potential of the area in question can be assessed. In most cases, the terrain analysis is carried out in a rather impressionistic way with no quantification of the degree of similarity between the ideal model and the

FIGURE 19

WOODLAND II
STUDY UNITS AND PROJECT AREA



KEY:

1 – PIEDMONT UPLANDS

2 – INTERIOR SWAMP/MARSH

3 – FALL LINE

4 – DELAWARE SHORE

5 – INTERIOR

6 – MID-DRAINAGE ZONE

7 – NORTH BAY SHORE

8 – SOUTH BAY SHORE – CAPE HENLOPEN

9 – MID-PENINSULAR DRAINAGE DIVIDE

10 – EMBAYED DRAINAGES

FIGURE 20

WOODLAND II SETTLEMENT MODEL-SLAUGHTER CREEK COMPLEX

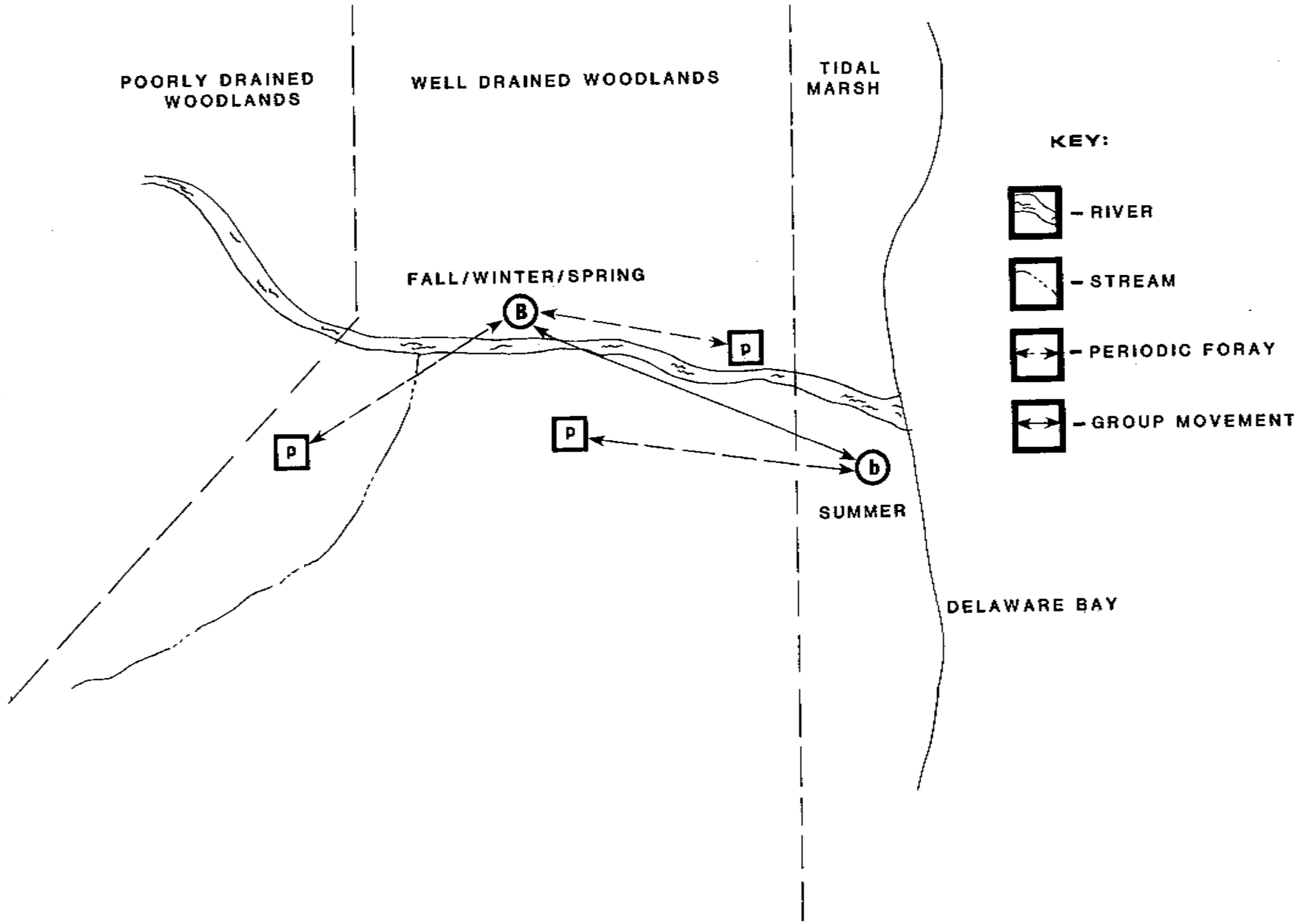
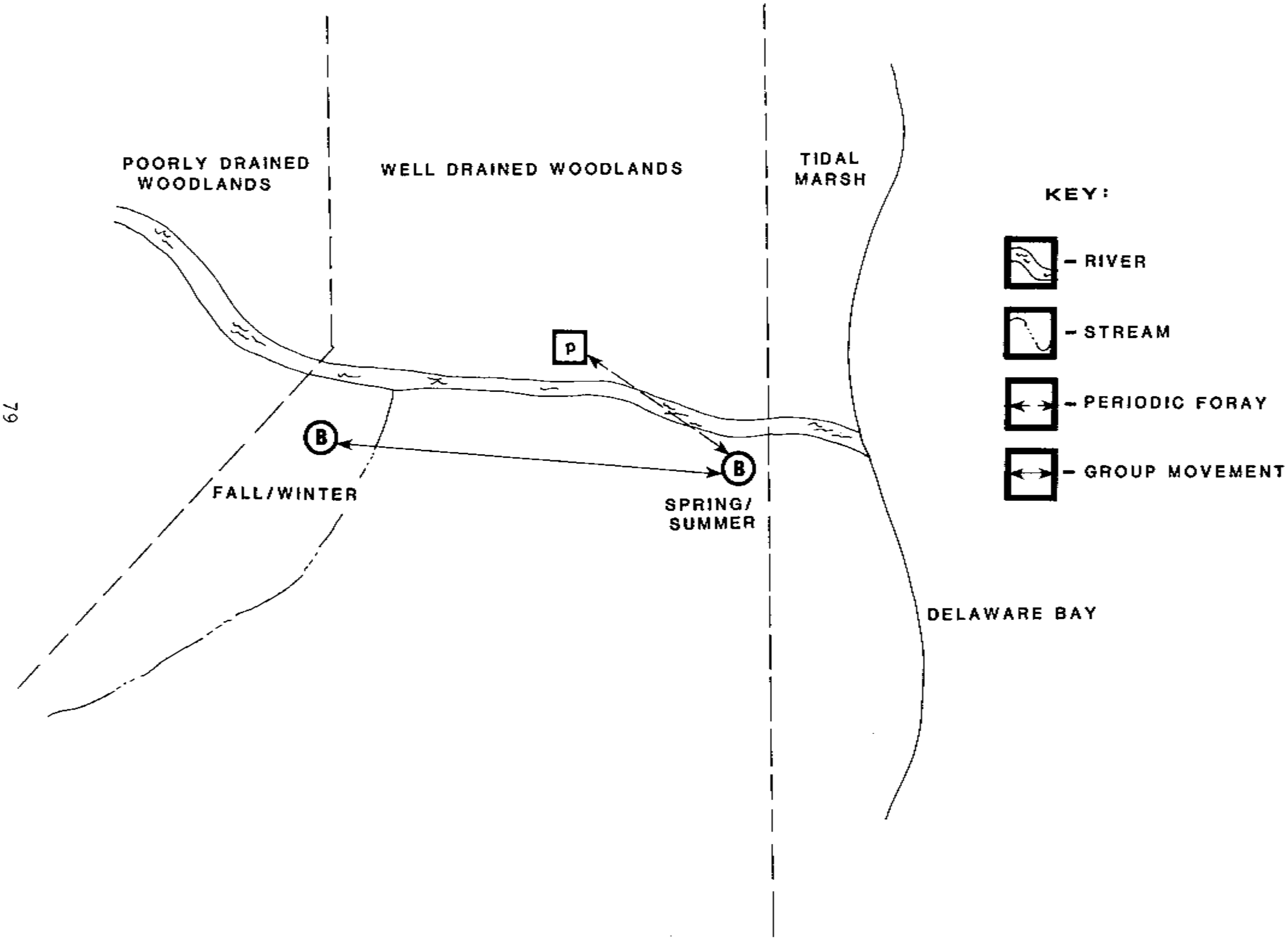


FIGURE 21

WOODLAND II SETTLEMENT MODEL–MINGUANNAN COMPLEX



actual terrain. However, newer techniques involving quantitative analysis have been developed by the Center for Archaeological Research and the Center for Remote Sensing of the University of Delaware. These techniques are described below and the description is taken from Eveleigh et al. (1983). It should also be noted that the model described below is directly derived from the more impressionistic models noted above.

The research by the University of Delaware has been oriented specifically towards the use of environmental data generated by the LANDSAT satellite. The LANDSAT satellite passes over the Delmarva Peninsula every eighteen days at an altitude of 920 km (Klemas 1977:387) and records four wave lengths of light using a multispectral scanner and a return beam vidicon. The data are recorded and transmitted in digital form and analysis is carried out using digital data. LANDSAT data can be used to classify and map various types of environmental zones by first identifying special categories of land classes on the ground. These areas called training sets can then be identified on the LANDSAT image and the special spectral characteristics of that area can be determined using a variety of statistical techniques (Klemas 1977). Once the special spectral characteristics have been identified, other elements of the LANDSAT image, called pixels, can be compared to the original training set and classified accordingly. Mapping of environmental zones using LANDSAT is quite accurate and comparative studies of remote sensing methods and ground truth data indicate that LANDSAT data produces accurate classifications 87% of the time in coastal environmental settings (Klemas 1977:387). Also, the resolution of the mapping is approximately 80 meters which can discriminate among closely spaced environmental zones. Probably the most important feature of LANDSAT mapping of environmental zones, however, is the fact that it can allow the mapping of large areas very quickly and inexpensively.

Several researchers have attempted to apply LANDSAT data to archaeological studies. In most cases LANDSAT data have been used to map out varied environmental zones that can be correlated in a general way with archaeological site distributions (Hamlin 1977; Schalk and Lyons 1976). However, none of these studies have been able to generate specific maps of zones likely to contain archaeological sites. The major difficulty in applying LANDSAT data has been that most archaeologists who work with remote sensing techniques have attempted to look for specific on-the-ground features, such as crop marks, shell scatters, or architectural features, to locate archaeological sites (Ebert and Lyons 1976). Because for resolution of the LANDSAT data is 80m it is generally unsuitable for the specific remote sensing of archaeological sites, although it should be noted that Quann and Bevan (1977) were able to recognize the shadow of the pyramids at Giza. Nevertheless, given the non-spectacular nature of the archaeological remains in the Middle Atlantic region, specific sensing of archaeological sites using LANDSAT is unlikely to succeed in all but a very few cases.

The work of Ian Wells (1981; Wells et al. 1981) provides an alternative approach to the application of LANDSAT data to archaeological modeling. Wells' work did not use LANDSAT data directly to generate an archaeological predictive model; however, he did use a geographic data base that was similar to those that can be generated from LANDSAT. Rather than look for specific variables that could be correlated with archaeological site locations, Wells considered combinations of environmental variables derived from the general models noted above that could be quantitatively correlated with known locations of archaeological sites such as distance to surface water of varying orders, distance to interfaces of well-drained and poorly drained soils, and the presence of special topographic features such as sinkholes, bay/basin features, or river levees (Wells

1981:41-46). This kind of synoptic analysis is different from specific analysis in that it considers regional combinations of variables relevant to archaeological site locations rather than indications of specific site locations. As such, it was able to take advantage of the best features of the LANDSAT data.

Wells used a statistical technique known as a logistical regression (Chung 1978) to analyze the relationship between locations of known archaeological sites, as well as locations known not to contain archaeological sites, and environmental variables. Although other statistical methods have been successfully used in similar analyses (eg., Kvamme 1981), the logistical regression model was used because it can be applied to gridded data bases, there are few restrictions on the distributions of independent variables, the dependent variable always lies between 0 and 1, and the algorithm is robust and can produce results even from noisy data (Wells 1981:23). The form of the logistic model, which estimates the probability that a certain cell contains at least one site is (Wells 1981:24):

$$\mathrm{PROB}(Y(i)=1) \quad = \quad E(Y(i)) = \frac{e^{X(i)'b}}{1+e^{E(i)'b}}$$

where

$$X(i)' = (1, X_{i1}, X_{12}, \ldots X_{ip})$$

is a vector of the p predictor variables at grid cell i and

$$b = (b_0, b_1, \ldots b_p)$$

is a vector of regression coefficients to be estimated. Y(i) is the independent variable between 0 and 1. The input to the logistical regression model consists of the Y(i) of known test sites (i.e., the probability value of 1 for locations known to contain archaeological sites and the probability value of 0 for locations known not to contain archaeological sites) and X(i), the observational values of the environmental variables.

A series of computer programs, called the ODESSA system, was developed by Wells to apply the logistical regression to an archaeological predictive problem. Simply stated, the ODESSA model first derived a logistical regression equation using the results of an archaeological survey of a section of the north bank of the Appoquinimink River in southern New Castle County (Gardner and Stewart 1978) as a training set. The environmental variables utilized were: distance to closest minor stream, distance to major stream or river (recognized in the data base as a dammed lake or reservior), distance to openland rated (well-drained) soil, local gradient, convexity of the landscape, and distance to present marsh (Wells 1982:41-46). All of these variables were recorded for the study area in a 500' grid cell data base AERIS system developed for planning purposes in New Castle county. The ODESSA equations derived from the training set were in a sense a linear series of coefficients such that if the observed distances and variables were multiplied by the distance and observations for the variables, a location known to contain a prehistoric archaeological site would generate a value for the equation of 1. Similarly, a site known not to contain a site would generate a value of 0. Using an analysis of variance, the equations developed by Wells accounted for 72% of the variation of site locations in the training set (Wells 1981:41).

After the equations were developed, the ODESSA system was applied to an area that previously had not been archaeologically surveyed. The environmental variables for each cell were input to the previously developed equation and each cell's variables produced a value between 0 and 1. This value is the probability that the unsurveyed cell will contain an archaeological site. Wells produced a map of the cells likely to contain sites (p .1) and field checks showed the predictions to be quite accurate (Wells 1981:49-54). In sum, Wells' use of the ODESSA model provides a way in which data similar to that gathered by LANDSAT can be quantitatively linked to archaeological site locations on a synoptic basis. Most importantly, the ODESSA model produced probability maps for archaeological site locations. These probability maps can be applied to this corridor study for the Middletown and Saint Georges quadrangle maps and are noted in Attachment IV. However, the ODESSA system did not use LANDSAT data and it was somewhat limited in its applicability in that it used an area of relatively limited environmental diversity (a floodplain and adjacent headlands) as a training set.

A more recent study of the Kent County area (Eveleigh et al. 1983) took the ODESSA model, with its use of the logistical regression analysis, and directly applied it to a new training set from the Kent County area that included a grid cell data base of environmental variables developed directly from LANDSAT. A sample of site areas from the St. Jones/Murderkill drainage area was chosen as a training set because it was a controlled, stratified, random sample of a variety of environmental settings. Also, the Kent County area's general environmental structure was similar to the Appoquinimink area studied by Wells. Finally, the time range of the majority of sites discovered in both the Appoquinimink and St. Jones-Murderkill area was the same (ca. 3000 B.C. - A.D. 1000).

The analysis of LANDSAT data from the Kent County study area can be directly applied to the proposed DelDOT project area south of the Appoquinimink drainage. Development of an appropriate data base was essentially one of proper classification of a LANDSAT scene. The LANDSAT scene chosen for analysis was taken during March 1979 because it was clear, cloudless, and had very little banding. A March scene was especially useful for classification, based on the variables seen to be useful in Wells' study, because the overall vegetation productivity was low and, consequently, the near IR channel (Band 7) was not oversaturated. This means that on the LANDSAT scene trees stand out a dark purple, wetlands appear as a mottled mixture of pink and blue-grey, and agricultural fields with varied cover (based on drainage characteristics of the soil) show up as reds and pinks of varying brightness. Drainage features appear as dendritic patterns varying from black to light blue depending on water turbidity.

After the scene was chosen a series of analyses were carried out to generate a useful classification. The first step was to download a small subset of data from two LANDSAT Computer Compatible Tapes (CCT) using the SUBSET program of the ORSER computer program package which is available from the Office for Remote Sensing of Earth Resources, University of Pennsylvania. This provided a subset of the original scene that was statistically debanded after one iteration of the NMAP program of the ORSER package. At this point classification could be carried out using other ORSER sub-routines; however, further analysis of the Murderkill area was carried out using the Earth Resources Data Analysis Systems (ERDAS) system owned by the Center for Remote Sensing, College of Marine Studies, University of Delaware.

Classification of the LANDSAT image was accomplished by applying a training program (FIELD). In this program the operator interactively picks a series of LANDSAT sensing units (pixels) that seem to have similar spectral characteristics and which seem to match with culturally significant (Chenhall 1975) environmental variables. The FIELD program reports on the spectral characteristics and purity of the series by displaying histograms of pixel brightness and a series of statistical indicators. As accurate and useful classifications are obtained, they are saved in a signature catalogue file. This type of classification is termed a supervised classification (Klemas 1977:389) and 16 specified signatures were generated for the Murderkill area. These signatures and their spatial distribution were then compared to infrared aerial photographs, color aerial photographs, and USGS topographic maps to insure their utility. Table 12 lists the variables that were utilized in the final classified scene.

After the LANDSAT image had been classified into useful variables, it was necessary to convert the image into a gridded data base. A series of programs was written to convert the classified LANDSAT data into a gridded data base and to add the data on the presence or absence of archaeological sites generated from the sample archaeological survey of the Kent County area (Eveleigh et al. 1983; Custer and Galasso 1983). In general, these programs created a gridded data base similar to the AERIS data base from a classified LANDSAT image.

The data base generated by the program contained a number of variables including percentages of ground truth grid cells that were classified into the variables listed in Table 12, and a series of minimum distance measures (converted to log distances) to a series of critical environmental variables (Table 12) similar to those shown to be important by Wells (1981:41-46). These variables formed the data base that was utilized in the ODESSA logistical regression model 12. The regression model was initially run using the variables listed in Table 1 and converged on a solution. The fact that the model converges on a solution implies that the variables selected do have some meaning for predicting locations. Unfortunately, there was an insufficient number of cases where no archaeological sites were located in the training set to carry out an analysis of variance for these runs of the regression models.

Table 12

Variables used in LANDSAT classification

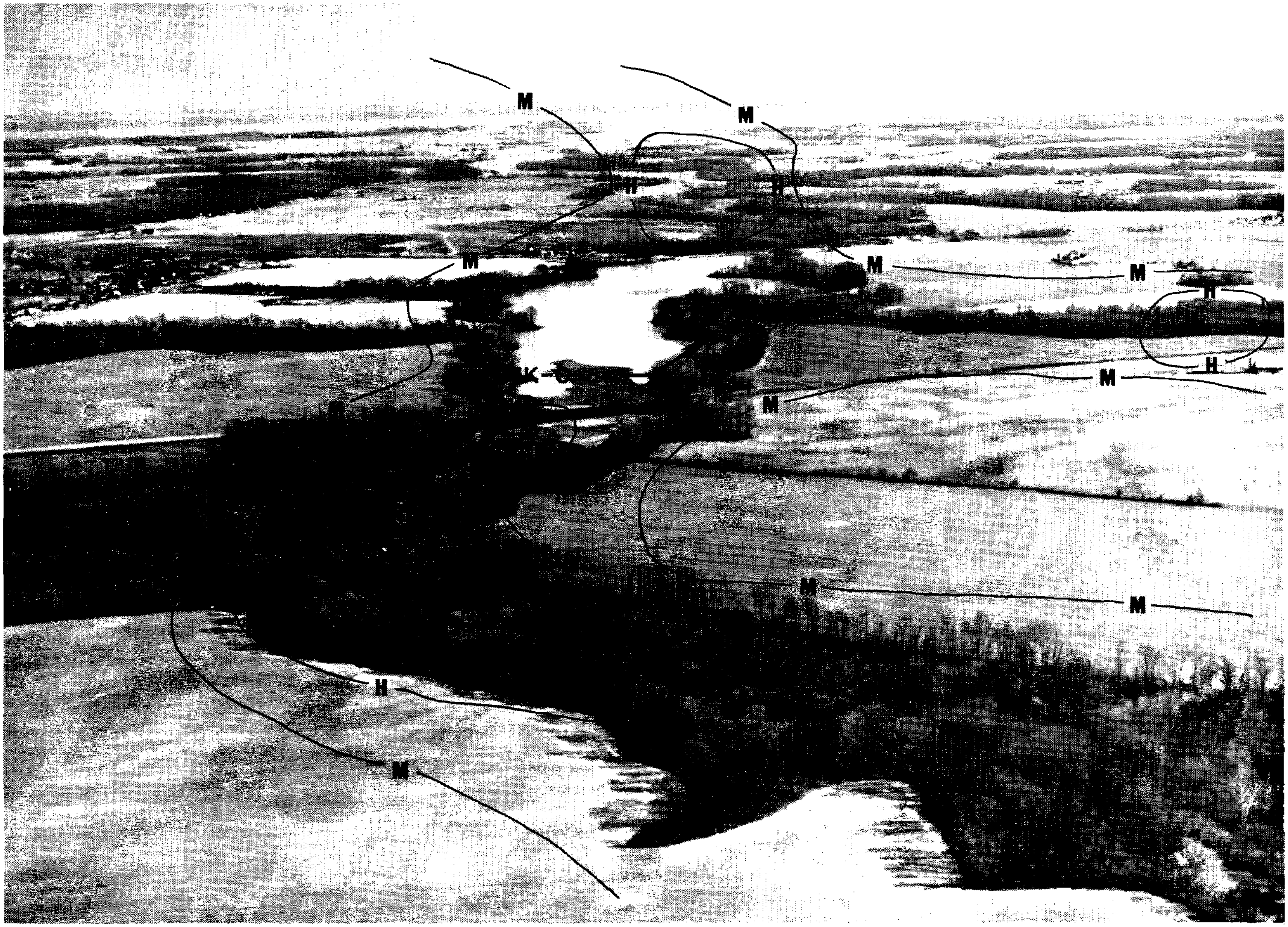
Variable Label	Ground Description	Edaphic Factor
Deep Water	Bay and deeper parts of rivers	High order streams
Shallow, Turbid Water	Turbid sections of rivers	Moderate order streams
Shallow, Clear Water	Less turbid sections of rivers	Low order streams
Salt Marsh 1	Tidal wetland with low productivity	High salinity marshes
Salt Marsh 2	Tidal wetland with high productivity	Brackish and low salinity marshes
Trees	Wooded areas	Very poorly drained soils
Agricultural 1	High productivity farm land	Well-drained soils with some moisture retention
Agricultural 2	Low productivity farm land	Well-drained soils with little moisture retention
Bare Soil 1	Bare soils, dead grasses	Moderately drained soils
Bare Soil 2	Bare soil, dead grasses	Moderately drained soils

After the model had converged on a solution, the sections of the study area that had not been included as part of the 5% stratified, random sample were run through the regression equation and the probabilities for each cell were noted. Contour maps of the site probabilities are provided in Attachment IV (Plates 3 and 4).

It should be noted that an initial test of the model's predictions was provided by Eveleigh et al. (1983). In order to test the accuracy of the predictions of the logistical regression model, the predicted higher probability locations were compared to known archaeological site locations within the classified area. Although the best test would have been to stratify the area by the probability

PLATE 3

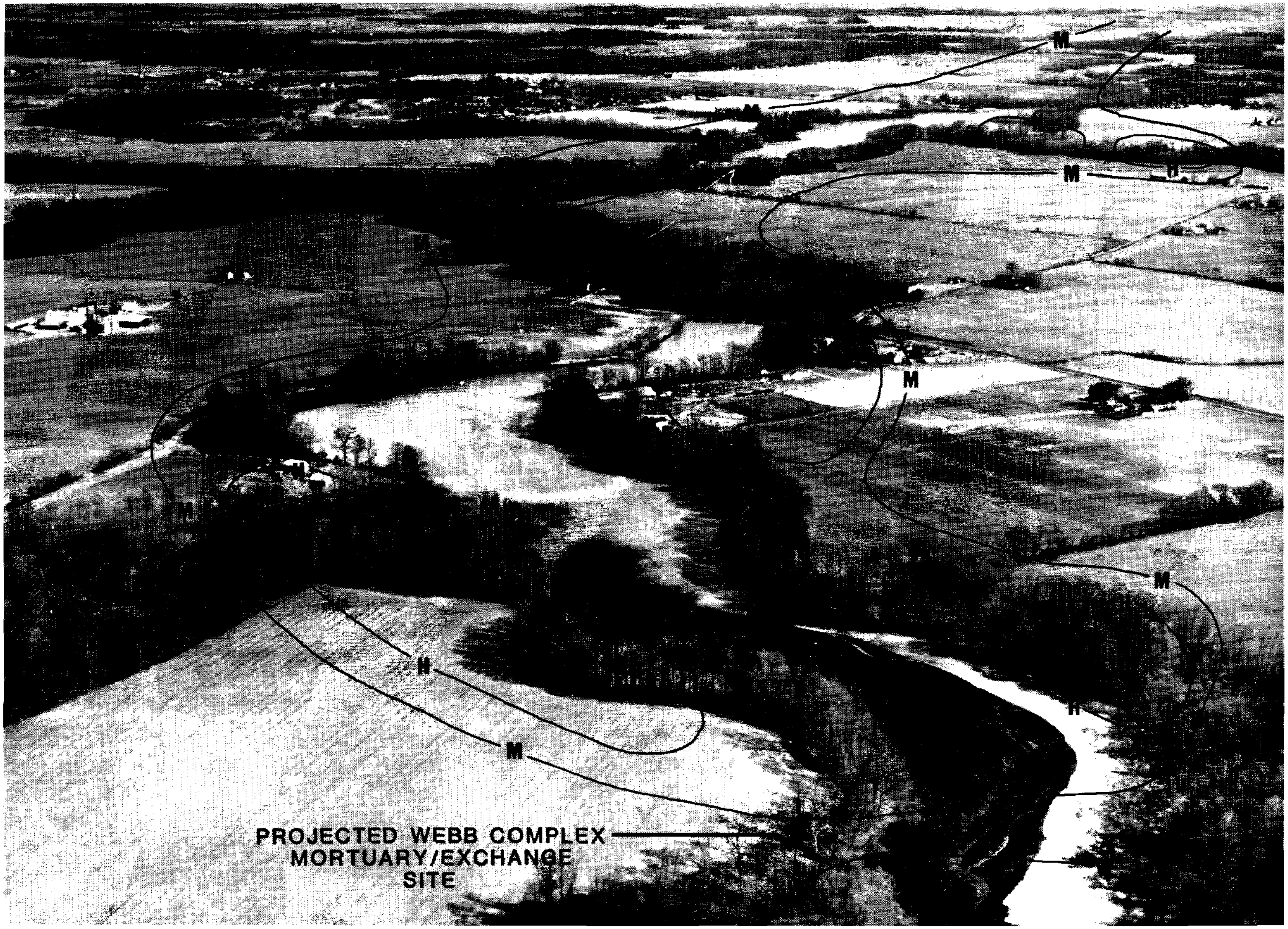
TYPICAL HIGH and MEDIUM PROBABILITY ZONES



LEIPSIC RIVER DRAINAGE

PLATE 4

TYPICAL HIGH and MEDIUM PROBABILTY ZONES



LEIPSIC RIVER DRAINAGE

values and then resurvey the area, this would have been prohibitively expensive. Fortunately, there was a high density of surveyed ares and known site locations within the Kent County survey area, and although these locations represent a biased sample, they do provide an initial test of the model's predictive accuracy.

In order to test the model's predictive accuracy, three probability classes (p .50, $.50 < p. < 75$, and $p. > 75$) were mapped using the original survey grid. The test utilized known sites and previously surveyed areas that were not included in the training set of the model and focused on the two higher probability zones. Specifically, the test of the model's accuracy considered each grid unit that was predicted to have a high or medium probability of having a site and checked to see if a site was truly present. This approach to model testing is consistent with the procedures for using hidden data as described by Snee (1977). Table 12 lists the data quality for each of the probability classes tested. In the high probability zone, 47 (54%) of the 87 grid units had test data available. Of these units 45 (95%) contained prehistoric sites. In the medium probability zone, 34 (29%) units had test data available and 29 (85%) of these units contained sites. In each case these results provide an initial indication that locations predicted by the model to be very likely to contain sites do indeed contain archaeological sites. However, it should be noted that the test data are biased and the results should only be viewed as a preliminary successful test (Plate 5).

Table 13

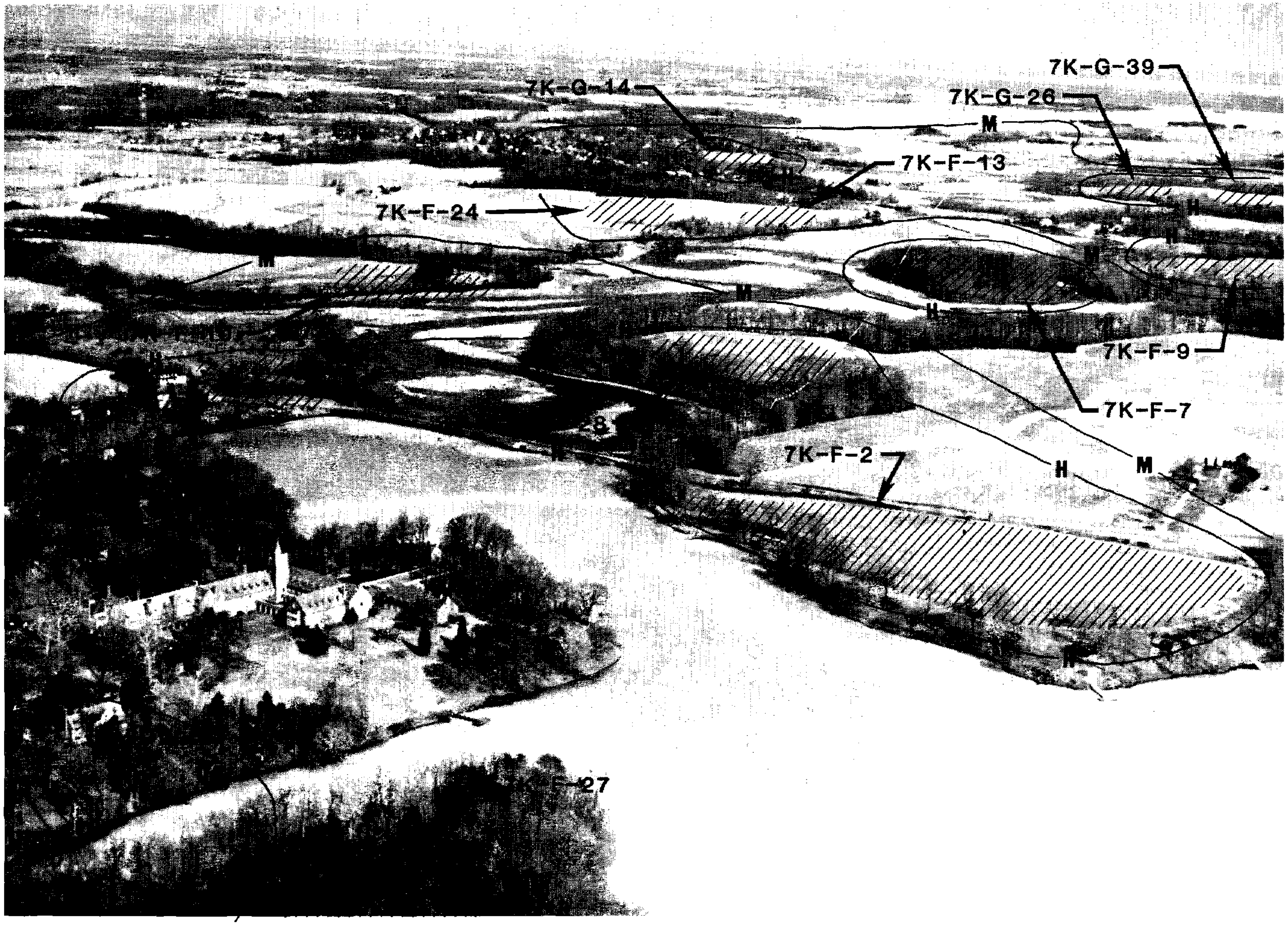
Test Data in Varied Probability

Classes

Probability Class	No Data	Developed	Marsh	No Site	Site Present	TOTAL
p .75	30	3	7	2	45	87
.50 p .75	69	2	12	5	29	117

PLATE 5

KNOWN SITES and PROBABILITY ZONES



APPOQUINNIMINK RIVER DRAINAGE

An additional component of settlement models not completely addressed in the LANDSAT analysis above includes mortuary/exchange centers of the Delmarva Adena and Webb complexes. However, other models which use cultural factors can be applied based on the work of Custer (1981). A cultural model of Delmarva Adena mortuary/exchange can be based on Price's (1982;n.d.) analysis of the development of ranked societies. Price notes that early ranked societies tend to redistribute labor rather than goods themselves. This labor is manifest in surpluses which in turn can be "invested" in sumptuary goods. "Big-man" systems of the Southwest Pacific (Harris 1979), are seen as an ethnographic analogy and trade and exchange is seen as an avenue for the consumption of specialized sumptuary goods (Custer 1982, 1983a:Chapt. 4). Burial of special artifact forms represents the ultimate conspicuous consumption and is a symbol of the organizational talents of the "big-man". In developing ranked social systems, such as the Delmarva Adena example, there is usually an absense of specific centers of trade and exchange management within a region due to competition among site centers and individuals for the labor base upon which surpluses are built. Therefore, the mortuary centers are not established in conjunction with any special local group. The central Delmarva Peninsula is seen as such a case where the low level of development of the "big man" system and competition for labor keeps any single group, localized at a macro-band base camp, from attaining a distinct advantage and control over the exchange and ritual system. The mortuary sites are seen as areas where higher ranking individuals from a series of base camps are interred. In one sense they are "neutral ground" and correspond in structure to "disembodied capitals" (Blanton 1978, 1980). Consequently, their locations are difficult to predict unless large portions of the contemporary settlement system are available for study and a central place model can be applied.

The central Kent County data base is sufficient to provide the beginnings of the development of social models for the location of Delmarva Adena and Webb Complex exchange center/mortuary sites. Between 600 BC and 200 BC (Thomas 1977:53) there are three main exchange center/mortuary sites in central Kent County: St. Jones Adena Site, Frederica Adena Site and the Killens Pond Site (Thomas 1970; Cubbage 1941). Gardner (1982) has suggested that these sites represent a developing hierarchy of sites within a ranked society. The larger sites like St. Jones and Frederica represent the top of the hierarchy while Killens Pond represents an intermediate level. A third level of special sites could include the numerous biface caches found throughout Delaware. However, these sites are difficult to date. The lowest level of the hierarchy would be the macro-band and micro-band base camps that represented the habitation sites for the people who participated in the system. The presence of exotic materials such as Flint Ridge chalcedony at these sites, as documented at 7K-D-37,38 and 7S-K-21 shows the linking of these centers to the exchange and mortuary ceremonialism processes (Delaware Division of Historical and Cultural Affairs 1978). A similar pattern seems to operate during the Webb Complex; however, data for the different levels of the hierarchy is not complete. The Island Field Site (7K-F-17) (Thomas and Warren 1970) represents the top of the hierarchy and the Hell Island Site (Thomas 1966) represents the base camp end along with the Carey Cedar Creek Site (7S-C-17). Data on the intermediate levels is lacking. Figures 17 and 18 summarize this model of the site locations.

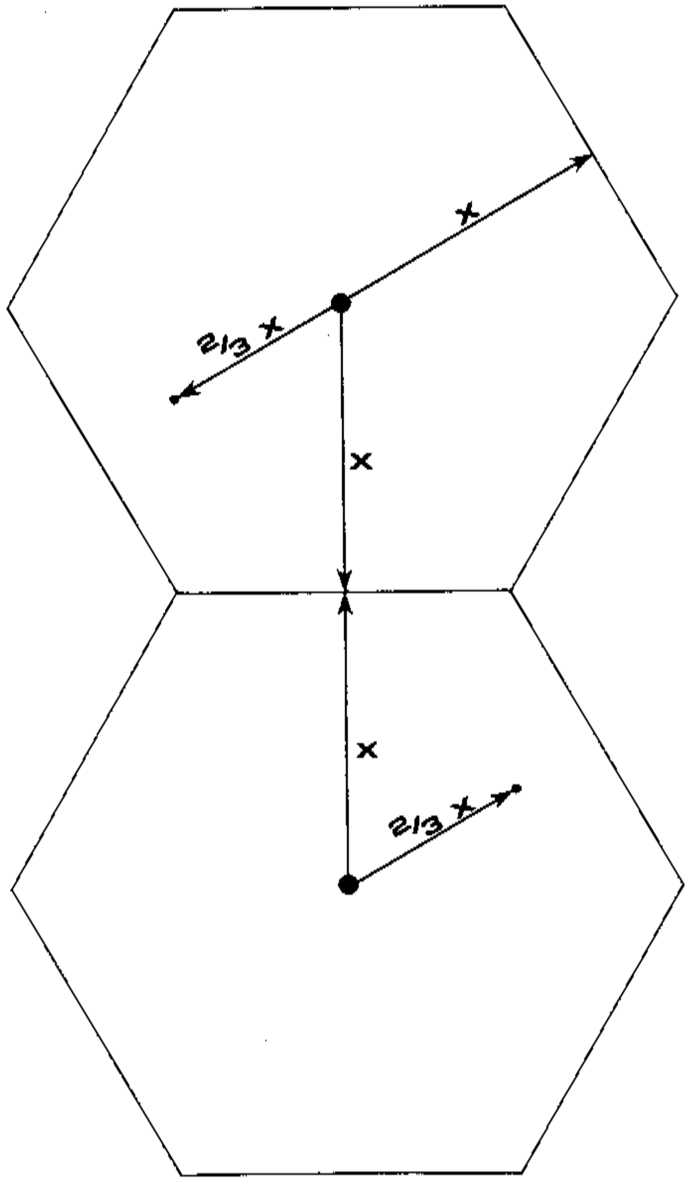
A consideration of the social settings of these sites and the use of models for similar societies in Mesoamerica allows the generation of a social model to predict the location of these special exchange center/mortuary complex sites. Earle (1976) has developed a locational model based on the analysis of Olmec ceremonial centers in southern Vera Cruz and Tabasco. The major centers of Laguna de los

Cerros, Tres Zapotes, San Lorenzo Tenochtitlan, and La Venta all appear to be regularly spaced. Price (n.d.) has noted that Olmec social organization is a prime example of labor redistributing complex chiefdoms and the regular placement of Olmec sites supports this contention. Earle (1976:219-221) also notes that territorial borders for the labor support zones associated with Olmec centers can be approximated by hexagons where the distance from the hexagon's central site to a side of the hexagon is equal to one half the distance between major site centers. Minor Olmec sites were also studied and were seen to fall within an area approximately two-thirds of the distance from the major center to a territorial border (Earle 1976:221). Figure 22 shows the relationship among the sites and this model can be applied to the Delmarva Adena Complex, and the Webb Complex, given the assumption that the basic pattern of socio-political organizations are similar to those of Olmec organizations. The similarity is seen in principle rather than scale. Both are seen here as ranked societies (Fried 1967) that redistribute labor. They differ in that much larger populations are included in the Olmec systems and more labor can be "invested" in social capital such as sumptuary goods and mortuary ceremonialism.

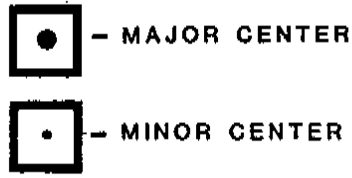
Application of the model to the Delmarva Adena data requires two assumptions. First, it is assumed that the St. Jones and Frederica sites were of a similar rank within the site hierarchy and were roughly contemporaneous. Thomas' (1970, 1975) data indicates that this is a reasonable assumption. Second, it is assumed that the Killens Pond site was at a lower level of the hierarchy and was part of the same network of sites. Based on these assumptions, the Frederica and St. Jones sites were viewed as a minimal pair of neighboring exchange center/mortuary complex sites. The distance between these two sites is 14 kilometers; therefore, hexagons with 7 kilometers from center to side would describe the territories associated with these major sites. Following Earle's model,

FIGURE 22

MORTUARY/EXCHANGE CENTER MODEL



KEY:



second level sites should be located two-thirds of the distance from the central site to the territorial border which in the Delaware case would be 4.6 kilometers from either the St. Jones or Frederica site. The Killens Pond site is located 4.8 kilometers from the Frederica site and therefore seems to confirm the initial application of Earle's model.

Application of the Mesoamerican model can be carried a step further and can be used to predict the locations of similar mortuary sites. With respect to the large primary mortuary sites, hexagons of the appropriate size (7 km from center to side) can be laid out for the Kent County area and locations of other hexagon centers predicted (Plate 6). These locations are noted on the maps in Attachment V. Using ecological factors that are associated with the known major sites it should be possible to pick out areas in the vicinity of the social predictions to look for major exchange center/mortuary ceremonial complex sites. When ecological factors are considered, a projected center near Leipsic, north of St. Jones, looks to be the most promising and is located close to the project area.

The social model can also be used to predict secondary site centers. Circles with a radius equal to two-thirds of the territory radius (4.8 km) can be plotted around the major centers, and projected major centers. The ecological settings of known secondary centers, such as Killens Pond, can then be used to pick areas along the circle that are most likely to be the sites of secondary ceremonial centers. The locations of these sites are also noted on the maps in Attachment IV.

A similar approach can be used to map out potential Webb Complex mortuary/exchange centers (Plate 7). Settlements pattern analyses presented by Eveleigh et al.(1983) and Wells et al.(1981) have shown that these special Webb Complex sites are located in lower probability zones ($p < .50$) that are either midway between combinations of high and medium probability zones (eg., Hell Island), or are encircled by a medium probability zone (eg., Island Field). Figure 23 shows the

PLATE 6
PROJECTED ADENA MORTUARY/EXCHANGE SITE

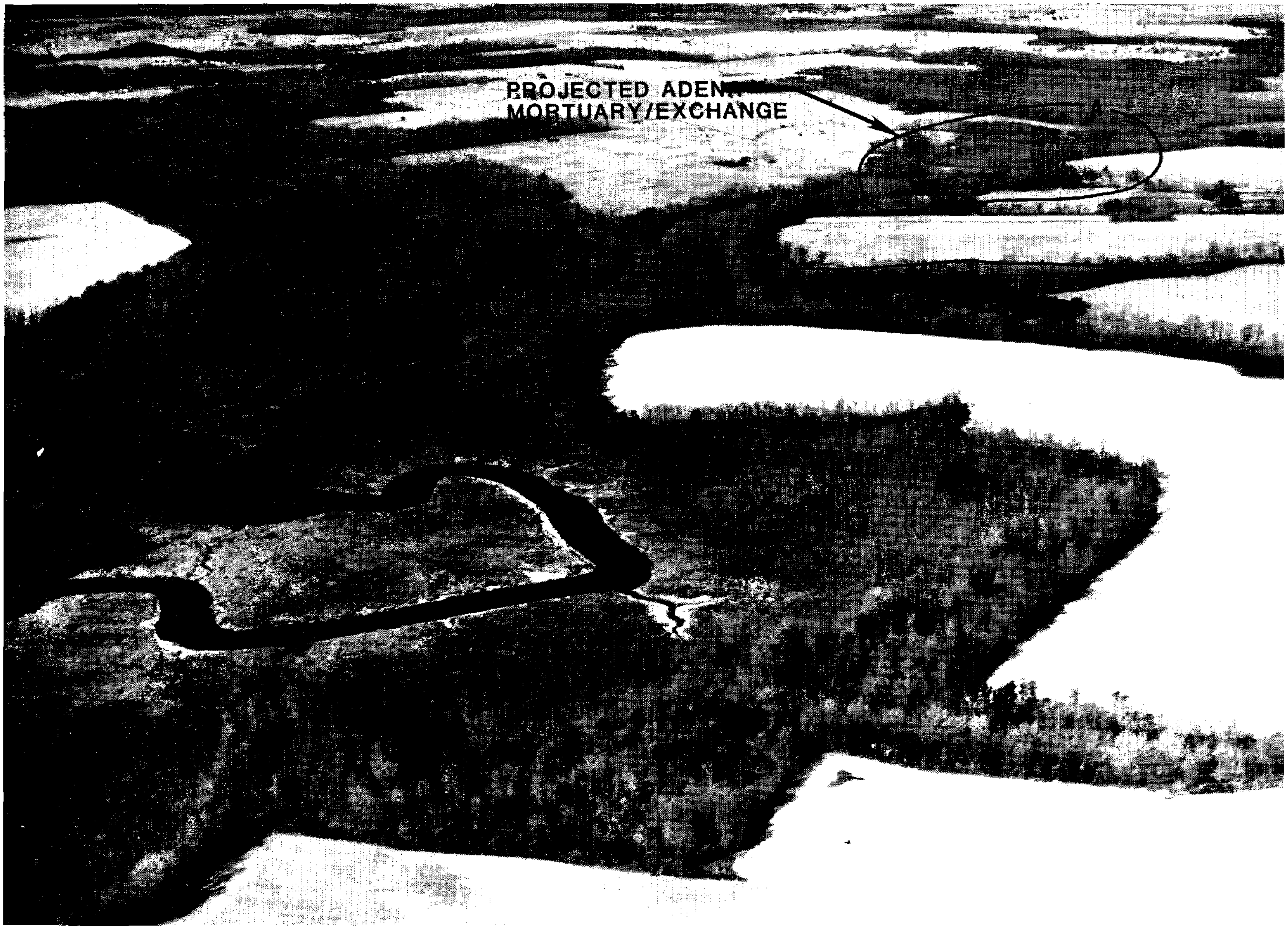


PLATE 7

PROJECTED WEBB COMPLEX MORTUARY/EXCHANGE SITE

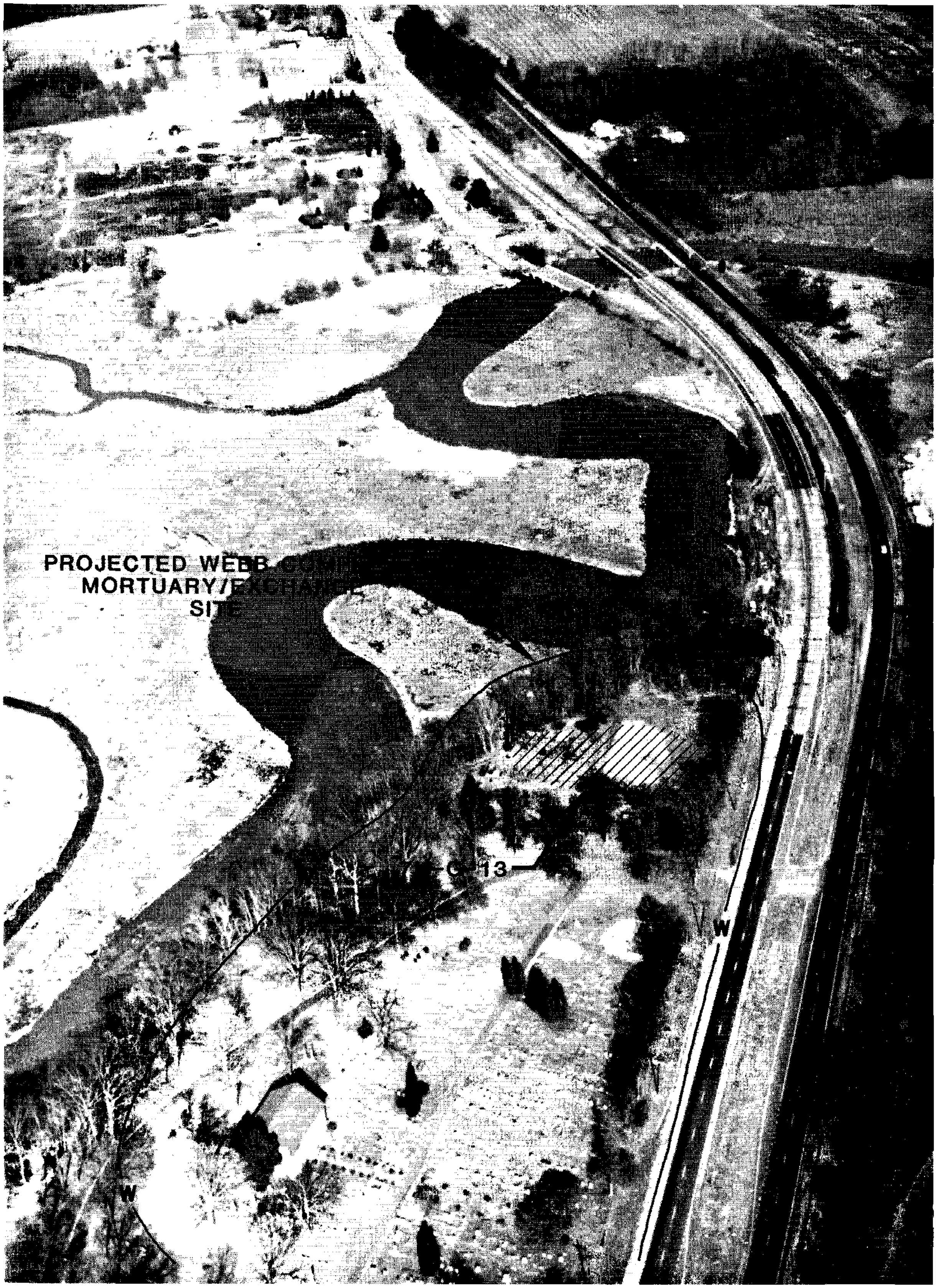
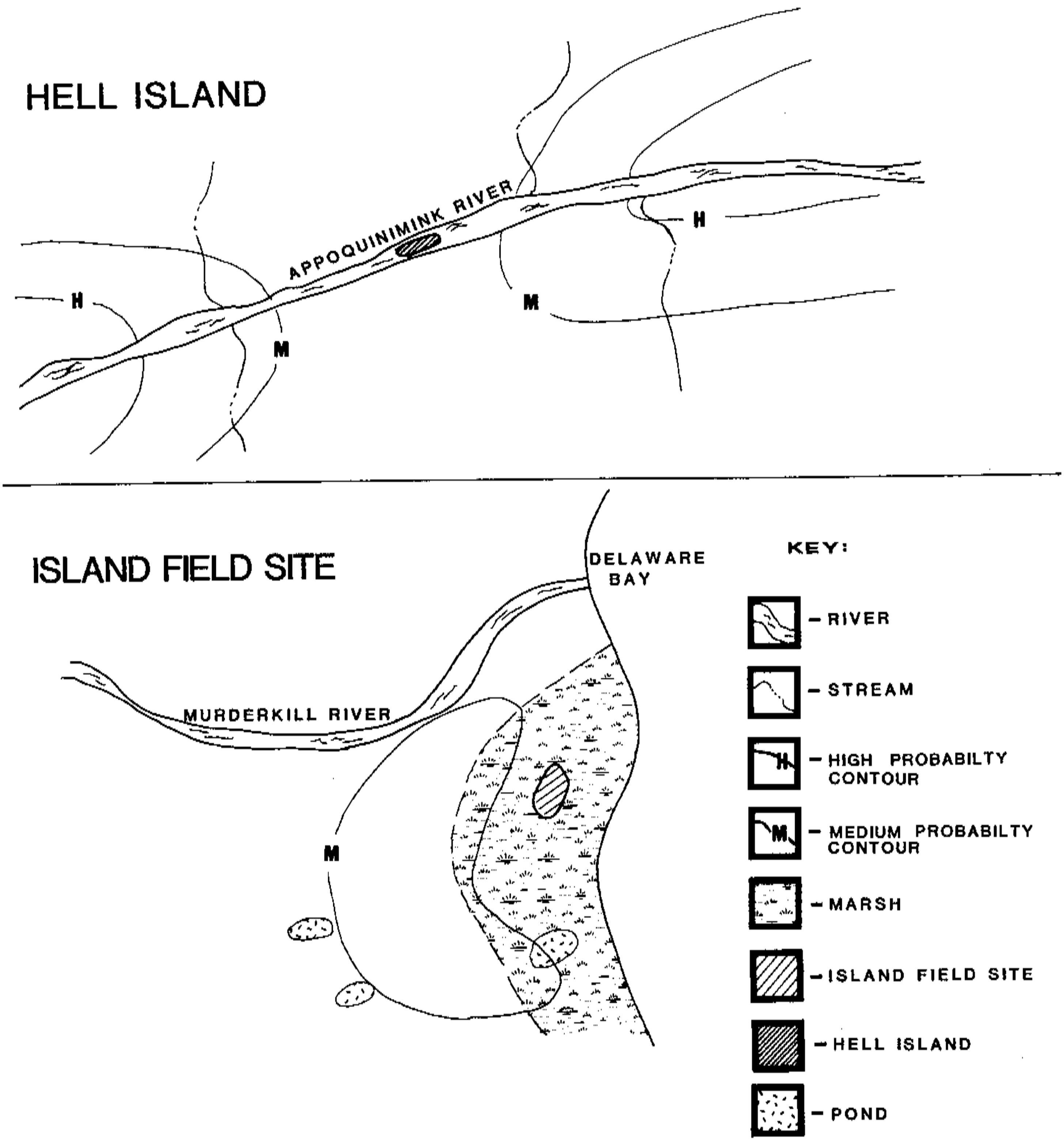


FIGURE 23

WEBB COMPLEX MORTUARY/EXCHANGE CENTER MODEL



pattern observed for the Hell Island and Island Field sites. The location pattern is related to central placement of special function sites in relation to population concentrations which represent labor and support population pools as was the case for the Delmarva Adena model. All potential locations of Webb Complex mortuary/exchange sites are noted in Attachment V.

In sum, the maps included in Attachment V outline high, medium, and low probability zones for prehistoric archaeological sites. Potential locations of Woodland I mortuary/exchange centers are also noted based on a social predictive model. The basic methods utilized and their predictions have been tested (Eveleigh et al. 1983:29) and seen to be accurate based on data from the southern portion of the study area. Table 14 notes the distribution of various dated components and site functions by probability zones for the entire project area based on known sites. Decreasing numbers of components are noted moving from high to low probability zones among various time periods and shown the general accuracy of predictions. However, the data base is inadequate for a comprehensive test of the models/predictions. Such a test must include a stratified sampling scheme and awaits further fieldwork. It should be noted that the presence of some sites in low probability zones indicates that sites may be present in this zone. The fact that the probability is greater than 0 and less than .50 does mean that sites will still be present, but with a much lower frequency than that seen in other zones. This low probability values do not preclude the presence of sites.

Table 14

Summary of Prehistoric Components by Probability Zones

		Probability Zone			
Site Types	Probabilty Zone	High	Medium	Low	Special
Archaic	macro-band	1	0	1	0
	micro-band	0	0	2	0
	procurement	1	1	0	0
Wood. I	macro-band	3	6	2	1
	micro-band	10	14	6	1
	procurement	4	9	3	1
Wood. II	macro-band	1	4	2	1
	micro-band	7	4	5	1
	procurement	1	1	0	1
Unknown		12	24	8	4
TOTAL		**40**	**63**	**29**	**10**

It should also be noted that the high probability zones will contain most of the macro-band base camps (Eveleigh et al. 1983:29-33) that have the greatest potential for being sufficiently significant to warrant nomination to the National Register of Historic Places. The potential mortuary/exchange sites are also all potentially eligible for nomination to the National Register. The medium probability zones contains mainly micro-band base camps (Eveleigh et al. 1983:29-33) which are also likely to be eligible for the National Register, but are smaller, and less expensive to study, than the sites in the high probability zones. The low probability zone contains mainly procurement sites which are much less significant, unlikely to be intact, and not likely candidates for the National Register. Even if they are deemed significant enough for listing on the register, they are the least expensive to mitigate. Thus, the probability zones shown in Attachment V are a guide to general locations of classes of sites of varying significance. Further discussion of management considerations is provided in the final section of this report.

The zones mapped in Attachment V can also be combined with the diagrams of typical site locations (Figures 5, 9-11, 14-18, 20-23) and lists of descriptions of typical locations (Tables 8-11) to note specific individual site locations within the study area. Appendix IV provides a listing of applicable models for each of the major high and medium probability zones on each map quad in Attachment V. Appendix V provides a technical discussion of the implications of the probability zones mapped in Attachment V.

Predictive Models and Historic Archaeological Sites

The main tools utilized in developing predictive models for historic sites included the inventories of standing structures contained in the BAHP files, which are listed in Appendix II and plotted in Attachment II, and the historic sites obtained from analyses of atlases, listed in Appendix III and plotted in Attachment III. Because the mapped sites represent the majority of the post-1802 historic settlement of the area, these maps can be used as a set of predictions of potential historic archaeological sites. The potential of each individual documented structure or site is assessed and listed in Appendices II and III. Attachment VII shows probability zones, included within contours, which contain concentrations of post-1802 historic sites. These mapped zones can be viewed as high probability zones. Areas not included in the zones can be viewed as low probability zones. No numerical values can be linked to these high probability assessments. Appendix VII provides a guide to the probability zones mapped in Attachment VII.

Unfortunately, few of the mapped standing structures that are noted in Attachment VII pre-date 1802. Therefore, it is necessary to develop a separate set of predictions based on the historic settlement pattern literature. An analysis of this literature is presented below. The discussion is divided between the Colonial Settlement Period (1638-1681) and the Initial Agrarian Settlement Period (1682-1802).

Settlement patterns in the project area from the Colonial Settlement Period (1638-1681) are extremely difficult to define because both archaeological investigation and documentary research for the period are in developmental stages. Wise (1978, 1979) has presented a preliminary model for settlement patterning in the early colonial period applicable to Dutch settlements in New Castle, Appoquinimink, St. Jones Neck, and Lewes. Research on the Chesapeake tidewater of Maryland and Virginia provides the most detailed data on early colonial settlement patterning in an area which shares environmental and economic similarities with Delaware (see Earle 1975; Kelly 1979; Custer 1983c; Wesler et al. 1981; Wesler 1982). The three sites in the Saint Georges Hundred identified in this report, and the studies noted above provide a limited basis for defining early colonial settlement patterning and plotting potential site locations.

Dispersed plantations and farmsteads close to the tidewater shoreline and water transport facilities were the predominant settlement types (Wise 1979; Earle 1975; Kelly 1979; Middleton 1953). The study area sites are located at the first extensive area of well-drained land along the Appoquinimink River-Drawyers Creek drainage system. The pattern of locating houses on well-drained soils within 300 feet of a drainage bank has also been identified by Wise (1978, 1979) in the St. Jones Neck area. The long-lot system of settlement, or variations on it, is seen on these early historic sites, in tidewater Delaware, Maryland and Virginia (Wise 1978, 1979; Earle 1975; Kelly 1979; Division of Historic and Cultural Affairs 1976:15), and would apply to sites in the project area. The long-lot system established linear land units extending from a shoreline or stream bank toward the drainage divide. Dwellings were constructed near the shore with agricultural lands behind. Distances ranging from one-quarter to one and one-half miles separated dwellings and resulted in a dispersed settlement pattern (Earle 1975). This system provided accessibility to the major water transportation routes for all landowners, demonstrating the strong water-orientation in communities where overland transportation networks were in initial developmental stages (Middleton 1953).

Structures present at early colonial agricultural complexes would have included small, wood frame dwellings and a wide variety of outbuildings: kitchens, meat houses, hen houses, milk houses, stables, bake houses, and grain and tobacco sheds (Earle 1975). Occupational specialists were limited in number and variety (Earle 1975), most likely because the early agricultural complexes maintained self-sufficiency by retaining part-time specialists thereby creating a limited demand for services. Docks and warehouses, and perhaps merchant offices and dwellings, are expected at the landing operations situated along the major streams and coastal zone.

Given the characteristics of settlement in the colonial period it is predicted that sites of this period will be uncommon within the proposed project area. Most sites will be located north and east of the project area. The Appoquinimink River-Drawyers Creek drainage area holds the highest potential for containing sites. In order to delineate actual settlement locations it will be necessary to research land grants, land patents and property deeds for specific localities. Kelly (1979) cautions that land patents are more likely to indicate actual settlement than are land grants and land sale records.

Settlement remained water-oriented during the Initial Agrarian Settlement Period (1682-1802) with settlements expanding up the navigable streams into headwater areas. A number of distinct settlement patterns are noted which reflect environmental and economic contraints, ports, landings, and agricultural complexes were established where well-drained land was available on the Delaware River-Delaware Bay shore. Port Penn, on the Delaware River, became a major redistribution-shipping center for central Delaware. Kitts Hummock, St. Augustine Creek Landing, and Bowers Beach were port settlements located at the mouths of major streams.

The presence of extensive marshland at the mouths of streams and along their lower reaches resulted in the establishment of inland landings and agricultural complexes. These settlement types were situated on the first available expanses of well-drained soils. All the inland settlements and landings established during this period in the proximity of the project area exhibit this pattern. They are: Red Lion on Red Lion Creek; Saint Georges on Saint Georges Creek; Cantwell's Bridge (now Odessa) on the Appoquinimink River; Taylors Bridge Landing and Blackbird Landing on Blackbird Creek; Flemings Landing, Brick-store Landing, Smyrna Landing, and Smyrna on the Smyrna River; Whitehall Landing, Fast Landing, and Leipsic on the Leipsic River; Little Creek Landing on the Little River; Dover on the St. Jones River; and Frederica on the Murderkill River.

The western limits of settlement were the headwater areas of the navigable streams and their major tributaries. Very little settlement occurred in the extensive areas along drainage divides between watersheds. Instead settlement was restricted to land in close proximity to major waterways. Water routes were the keystone of the transportation system, although overland travel was increasing as a far-ranging network of roadways developed (see Varlle and Shallus 1802). Indeed, a regional road network existed by the 1720's between the Dover area, the northern part of the colony, and Maryland's Eastern Shore and some settlement may be expected along these roads. However, without a doubt, the major focus of early settlement during this period remained along the major drainages.

Commercial transportation was tied to water routes because they provided a more economical mode than overland transport of bulky agricultural products (Middleton 1953). However, the movement of goods over short distances to processing and redistribution centers was often overland; especially in the inland hinterland. Intra-regional passenger travel between commercial centers and towns was facilitated by the development of the Philadelphia-Lewes postroad. While road travel was difficult and time-consuming, it often offered more direct routes than the waterways, which were oriented toward the Delaware River-Delaware Bay and better suited to transport market-oriented produce. Earle (1975) has identified a similar pattern of road development and use in tidewater Maryland.

Agrarian settlement was predominant, however. During the 1720s towns were established at the junction of major transportation routes and many of the towns grew from landings and hamlets. The site locational data collected for this project indicate three factors were important in the siting of early towns: 1) the availability of extensive areas of well-drained land; 2) proximity to a navigable stream; and 3) proximity to the Philadelphia-Lewes postroad (now Route 13/113), the Cheapeake Bay spur (now Route 301), or other road networks. These factors have also been noted by Wise (1979). The towns of Red Lion, Saint Georges, Mt. Pleasant, Cantwell's Bridge (Odessa), Leipsic, Smyrna, Dover, Frederica, Canterbury, and Camden, all early 18th century towns, possess these locational characteristics. Locational data also indicate that the early towns were situated at mid-drainage or further upstream settings (see Wise 1979). This pattern suggests that town sites were chosen near the heads of navigation of major streams and tributaries. The routing of the Philadelphia-Lewes postroad through the towns and the heads of navigation facilitated inland transportation and communication.

The siting of Middletown deviates from the patterns noted above because it is situated at the western edge of settlement on the drainage divide between the Appoquinimink River and Drawyers Creek watersheds. Its position on a major road to the eastern shore of Maryland, and at a terminous of numerous cartroads, encouraged its growth despite the absence of a navigable stream.

Towns were the loci of facilities for the storage and redistribution of agricultural surplus and processed goods. Population was concentrated in towns, although both population and town size was small. A traveller on the Philadelphia-

Lewes postroad in 1747 described Dover, a major center for the region, as a town of 20 houses (Wilkins and Quick 1976). Documentary research on the activities in early Delaware towns has been limited, although the distribution of settlement types within the project area and more detailed data available for adjacent areas allows the delineation of town patterning.

Mercantile concerns, shops, stores, and public offices represent the major services available to town residents and hinterland populations (Lemon 1972; Reps 1972; Earle 1975; Kelly 1979; Wise 1979). Craftsmen, mill complexes and manufactories were outside towns. Early towns have been described by some researchers as "cities" or "urban" in character because they served the function of urban centers for the agricultural hinterlands (Earle 1975; Kelly 1979; Wise 1979; Henry 1981). It is more likely that towns retained the characteristics of provincial towns well into the 19th century or later.

Farmsteads, plantations and estates were the predominant settlement type during this period. They were present within the limits of settlement discussed earlier in this section. Agricultural settlement was absent in the drainage divide areas. Because agricultural produce needed to be moved to processors or redistribution centers, agricultural settlements were 1) in close proximity to major streams and their tributaries or 2) along primary and secondary roads which linked the hinterland to landings and service centers. Landholdings were substantial in size and although extensive areas were settled, settlement density was low (see Varle and Shallus 1802; General Assembly of the State of Delaware 1899). Documentary research on landholdings in Maryland shows a mean plantation size of 430 acres (Kelly 1979). Kelly (1979) points out that land sales data suggest increases in settlement area and settlement density, when in fact, they reflect increases in individual landholdings as landowners' purchased adjacent tracts. Agricultural settlements contained a main house and a broad range of special function outbuildings, as well as residential quarters for tenants, agricultural laborers, servants, and slaves. In the 1750s, draining of marshland opened new areas to agricultural use in the lower reaches of Drawyers Creek, Appoquinimink River, and Leipsic River.

Mill complexes and agricultural mill complexes were conspicuous features on the rural landscape. Their distribution was of course limited by the need for water; however, they were located consistently at mid-drainage or further upstream on major streams and their tributaries. It is likely these locations were chosen because they are at the heads of navigation. Mills generally were located outside town, but their stream settings offered access to transport facilities. Numerous secondary roads linked the processing centers to the agricultural hinterland. There was an absence of mills on the lower portions of the major drainages which suggests that agricultural products were shipped unprocessed to markets. Interior produce apparently was processed and later transported to market, or processed goods were consumed by local markets and unprocessed surplus was shipped to outside markets.

Data on the distribution patterns of manufactories, the workshops of occupational specialists and other types of sites are very limited for the study area. Only one manufactory was identified for this period, although it fits the pattern recognized by reasearchers working in other areas. Like mills, manufactories and workshops were situated within the agricultural hinterland in order to be accessible to the agricultural community requiring their services (see Lemon 1972; Earle 1975; Kelly 1979; Wise 1979; Bachman et al. 1983). Traverns were located along heavily travelled post and cart roads, most frequently at crossroads or junctions with landings and streams. The examination of 18th century maps will be necessary to more fully discern the distribution of taverns within the project area. Shifts in the usage of structures as residences and taverns over time makes positive identification of taverns difficult. Generally taverns were spaced the distance an overland traveller could ride in one day, but often a traveller found shelter in a farmhouse along the route. Churches were located in towns and in rural settings. Rural churches were found on secondary roads accessible to the agricultural population.

A substantial number of sites of this period have been identified within the proposed project area. More sites conforming to the settlement patterns and settlement types presented above are expected. Attachment V maps out the probability zones for potential pre-1802 settlement based on the above settlement pattern analysis and also notes the few known pre-1802 sites. Appendix VI provides a guide to Attachment VI. Saint Georges and Mt. Pleasant are the only towns established in the early 18th century within the proposed project area. Many of the early 18th century ports, landing, plantations, and farmsteads lay outside the project area on the lower reaches of streams and on the Delaware River-Delaware Bay shore.

During the post-1802 period marked settlement pattern shifts can be noted within the project area and a description of these changes, based on an analysis of the predicted zones noted in Attachment VII is presented below. Appendix VII provides a guide to Attachment VII.

Major shifts in settlement patterning occurred within the project area during the full Agrarian Settlement Period (1803-1868) primarily in response to railroad and canal construction. Choices in settlement location were no longer constrained by water accessibility and major settlement expansion was felt in the upland zones between watersheds, especially on the high, well-drained soils along the drainage divide separating the Chesapeake Bay and Delaware River-Delaware Bay watersheds. This vast area contained agriculturally productive land, but the high cost of overland transportation had limited its value in earlier periods. In previously settled areas, unoccupied land on the drainage divides came into agricultural production. There was a continuation of the water-oriented settlement patterns established earlier because they remained economically viable. New roads linked the older transportation system and the newly established canal and railroad routes. The construction of the railroad and the canal, however, was not the only factor in settlement expansion. Increasing population pressure in settled areas and the growing demand of the interregional markets for agricultural products made the construction of the new transportation routes economically feasible. The location of the railroad and canal had profound influence on the patterning of settlement into the 20th century.

Roads became more important as factors in settlement location at this period progressed. No longer were the major streams and primary roads the foci of settlement. An extensive network of roads was established in the newly settled agricultural hinterland and these roads linked farmsteads and agricultural hamlets to the redistribution centers and to the canal, rail lines, and streams. The railroad and the canal served to channel agricultural surplus from the hinterland to the large, domestic markets. Population growth and settlement density were highest between the Philadelphia-Lewes postroad and the railroad line which paralled it to the west. The major service centers within the study area were situated on one of these routes or on the canal.

The establishment of new towns and the growth of existing towns and hamlets was an important response to the new transportation corridors in that the new towns were not restricted by earlier environmental and economic constraints. Towns appear on the perimeters of watersheds and on drainage divides which were once obstacles to agricultural settlement and could never have supported town growth. Surrounding the new towns was a large agricultural hinterland occupying similarly situated land.

Saint Georges was already important as a local center due to its position at the junction of a major north-south road and Saint Georges Creek. The canal enabled Saint Georges to increase its influence as a redistribution center and command a larger share of the growing agricultural surpluse of the hinterland.

Dover, Smyrna and Cantwell's Bridge (Odessa) emerged as intra-regional centers because rail, road and water transportation routes converged in these already etablished centers. These towns controlled extensive hinterlands and they provided a wide range of business and comnmercial services for the rural population. The broad range of services provided employment for the large, concentrated non-agricultural population. While these towns played increasingly important roles in the intra-regional economy, they were still subordinate to the inter-regional centers, Philadelphia, Baltimore, and Wilmington.

Local centers, such as Clayton, Townsend, Cheswold, Sassafras Station (Green Spring), Kenton, Wyoming, and Woodside, were established specifically to store and redistribute agricultural products. Middletown experienced heavy growth as a railroad town. Each of the towns exerted influence over a small rural hinterland and were also the loci of stores, banks, hotels, railroad stations, commercial offices, physicians' offices, and post offices. The new towns exhibited regularized street plans and clearly defined residential and commercial districts. These patterns are not seen in older communities which developed by accretion.

The improvement of roadways encouraged additional settlement throughout the region. A primarily agrarian pattern of settlement consisting of farmsteads, workshops, manufactories, processing facilities, crossroad towns, churches, and schools were scattered along the primary and secondary roadways. The farmsteads were involved in market crop production and farm products were transported to nearby centers.

The substantial number of agricultural tenant dwellings and farms in the region indicates the presence of a large body of landless agricultural laborers. The distributional pattern of agricultural tenant-related structures in rural areas indicated the majority were situated close to the roadways. Further research is required to verify this pattern and to explain the differences in the distribution of tenant-related structures and the residences of the landed population.

Hamlets and villages were established at the intersection of secondary roads which connected the hinterland to local and intra-regional centers and major transportation routes. The crossroad town provided the hinterland population with a restricted set of services, usually a general merchandise store and less frequently workshops. They also served as the loci of small population clusters. The ubiquitous "Corners" are found throughout the study area. Crossroad towns did not appear at the junction of all roads, but only at the junction of roads leading to larger centers or major transportation routes which exerted a "pull" on the hinterland products and the population requiring the services of the centers.

The majority of sites identified in the proposed project area date to this period. The settlement types discussed, excluding the intra-regional centers and most of the local centers, will be present in high numbers in the project area.

No major changes in the settlement patterns established during the preceeding period occurred during the Settlement Stabilization and Agrarian Maintenance Period (1869-1910). The hierarchical structure of settlement types described in the previous section presisted. New centers did not develop during this period because the economic and environmental constraints operative earlier resulted in the siting of centers in highly advantageous locations. Subsequent technological and transportation improvements served only to increase the agricultural productivity of the hinterland and the spheres of influence of the local and intra-regional centers.

Population increases were significant within centers, but these are all outside the proposed project area. Few sites dating from this period have been identified; however, many of the sites established earlier continue to serve the same functions within the same settlement conditions.

Motorized transportation and upgrading of roads for automobile traffic encouraged distinctive settlement shifts during the Modern Period (1911-1950). Urban population growth continued and the concentration of commerce and industry increased. A more important shift was the expansion of a non-agricultural population into rural areas. Primary and secondary roads became the foci of residential settlement and small parcels of land along the roads were carved from large farm properties for single family dwellings. The farmsteads generally remained behind the new residential front and the character of the region remained agrarian. New settlement types for this period are the non-agricultural residences and automobile-related facilities. The pattern of settlment is essentially a composite or mosaic of earlier patterns superimposed one upon the other.

MANAGEMENT CONSIDERATIONS

Up to this point, this report has focused on listing the known and potential cultural resources for the proposed project area. In this section, we will: 1) consider the known and potential significance of the resources; 2) note those sections of the project area which are the most "sensitive" in terms of cultural resources: and 3) make recommendations about the future stages of the cultural resources management process. Specifically, we will note the sections of the project area which will require intensive archaeological research efforts to mitigate the effects of the proposed highway development and also note potential research methods and mitigation costs.